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EFFECT OF IRRADIATION OF THE THYMUS ON ARTIFICIAL FRACTURES IN WHITE RATS*

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THERE is a vast amount of literature dealing with the function of the thymus gland. As in all endocrine glands it is difficult to attribute experimental findings exclusively to the thymus. The relationship in the endocrine system is too close. Still we are entitled to say that removal of the thymus produces certain changes. There is no full accord in experimental findings obtained by the removal of the thymus; but there has been full agreement reached on the influence of the thymus on bones. Removal of the thymus produces in young animals retardation of growth and softening of bones. Morphologically there is some similarity with rickets, osteoporosis and osteomalacia (Basch, Klose and Cozzolino). It has been found that bones in animals deprived of thymus contain less calcium than those with thymus. The fact that extirpation of the thymus causes disturbances in the ossification and the natural diminution of the gland after the period of growth seems to be significant of the relation of this gland with the osseous system. It was therefore rather logical that Basch and Sommer made experiments on fractures after removal of the thymus. Their findings were in accord with the hitherto known bad callus formation and slow healing process.

A new experimental method was employed by Milani who destroyed the function of the thymus by means of very high doses of *x*-rays. The growth of the animals ceased and they died, as after the operative removal of the gland. Now it will be interesting to note the results of implantation of the thymus gland. Dehmel states the following findings in rats: Young animals are more lively and better developed in spite of increased obesity. The growth of bones is especially stimulated by implantation of glands from young animals. There is no difference in the strength of the bones. There is no apparent influence on other glands. Feeding of thymus substance showed no influence at all. This is in accordance with experiments of Sinnhuber whose results gave no evidence of any change in the calcium metabolism. The implantation method is not commonly used on human beings. Lesser and other investigators expressed some doubts about the value of this method.

On the other hand, some practical application of these experiments could be expected, if stimulation of the activity of the thymus could be achieved as for instance by means of small *x*-ray doses. In 1905 Heinecke discovered the hypersensitivity of the thymus gland to *x*-rays.

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He radiated the thymus of cats and after three and one half hours observed characteristic changes in the lymphoid tissues of the thymus gland (destruction of nuclei, phagocytosis of chromatin particles). Rudberg confirmed and carried out in detail these findings. The clinical result was radiation of the thymus in cases of hyperplasia, a method which gave very good results. Its aim is functional reduction of the activity of the gland.

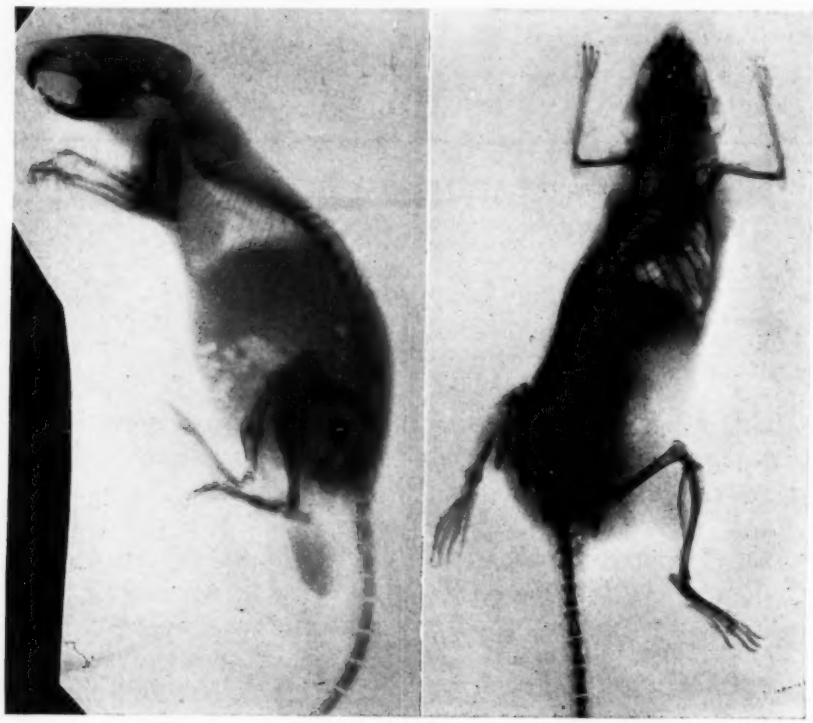

Fig. 1A. Fig. 1B.

Fig. 1. Experiment II.

A. Radiated animal. Fractured Sept. 17, 1930. Radiated, 10 per cent, Sept. 17, 1930. *X*-ray taken Oct. 21, 1930.
B. Control. Fractured Sept. 17, 1930. *X*-ray taken Oct. 21, 1930.

Experiments concerning the stimulation of the thymus were carried out by Lenz. He radiated the thymus of young rabbits with small doses of *x*-rays and studied the microscopical changes in the thymus and spleen at different intervals after the radiation. Lenz came to the conclusion that a hypofunctionating thymus cannot be stimulated by exposing it to roentgen rays in a fraction of an erythema dose. But there are no experiments concerning the influence of thymus irradiation on artificial bone fractures. As the most significant changes take place apparently in the bones, the healing of fractures represents the best test for any effect of the radiation. The experimental plan was therefore based upon radiation of the thymus with small doses after a fracture was set.

The application of small doses on endocrine glands is not new. It represents a valuable method in the treatment of amenorrhea. Radiation of the ovaries with the so-called "stimulation dose" gives good results in some cases, especially in secondary amenorrhea. No theoretical discussion about the stimulation dose is intended here. The rule of Arndt-Schultze is presumably applied for rays as it is for other biological processes.

In our experiments we used rats aged from three weeks to one year. One group was kept on standard diet consisting of milk, vegetables and bread. Another group

was kept on Steenbock diet for two weeks prior to the experiment. This was done to find out if the effect of radiation has any bearing on a low calcium content. The animals were of the same weight and taken from the same litter. To each group the same number of control animals were added. If the litter was sufficiently large the animals were divided into both groups. The femur was fractured under general anesthesia and an *x*-ray picture taken to verify the fracture. On the same day or twenty-four hours later radiation was applied to the thymus. We used hard filtered radiation: 200 kv., 4 ma., 0.8 Cu + 1 Al, 40 cm. distance. Great care was taken that the animals were completely immobilized during the radiation. The body was protected by means of rubber-lead and only an area of 1.5 cm. was left open as port of entry for the radiation. By this method the unnecessary space radiation was avoided and the best condition for an exclusive radiation of the thymus was given.

The question may arise whether the parathyroid glands were also affected by the radiation. If they were the effect was supposed to be similar to that on the thymus. Removal of the parathyroid glands would not have been the proper way to exclude the possible effect of the radiation. Their removal produces such great changes in the calcium metabolism and the nervous system, that no valuable observation would have been possible. Furthermore we know the results of the removal of the gland and could easily judge our findings from them.

In detail the results obtained are shown by Table 1.

The results of these experiments show in all cases a clear difference between the radiated and control animals. Callus formation set in one to two weeks later in the control animals. The complete healing which was judged by a satisfactory callus formation on the *x*-ray plate and the clinical examination, showed an average of three weeks in the radiated animals against four weeks in the control. It is impossible to define the beginning of callus formation exactly to the day. The animals had to be anesthetized whenever a picture

Fig. 2A. Fig. 2B.

Fig. 2. Experiment III.

A. Radiated animal. Fractured Oct. 13, 1930. Radiated, 10 per cent, Oct. 13, 1930. *X*-ray taken Nov. 5, 1930.

B. Control. Fractured Oct. 13, 1930. *X*-ray taken Nov. 5, 1930.

was taken and a possible damage from the frequent anesthetics had to be avoided. All other conditions being equal the radiation of the thymus must be held responsible for the quicker repair of the fractures.

It is rather surprising that the old animals responded as well as the young animals. That this is not a mere coincidence is proved by the reaction of the animals of different ages in the two groups. The healing of the fractures in young animals requires the same time as in the oldest ones. This is absolutely in accordance with anatomical and physiological studies which prove that the remaining thymus tissue after the normal involution keeps its function up to old age. Waldeyer found thymus tissue in men aged from sixty to eighty. Svehla observed that the application of

TABLE I
(Regular Stock Diet)

Group	No. of Animal	Age	Date of Fracture	Date of Radiation	Dosage	Callus Formation after:			
						2 Weeks	3 Weeks	4 Weeks	5 Weeks
	512	3	9–9–30	9–9–30	10 per cent	+	+++		
	513				Sk. E. D.	+	+++		
	514	weeks	do.	do.		+	+++		
	515		do.	do.	do.	+	+++		
	516			Control	Control	−	+	+++	
	517				do.	−	+	+++	
	518	do.	do.	do.	do.	−	+	+++	
	519				do.	−	+	+++	
	524	4	10–13–30	10–13–30	10 per cent	++	+++		
	525		do.	do.	Sk. E. D.	++	+++		
	526	months			25 per cent	++	+++		
II	527		do.	do.	Sk. E. D.	++	+++		
	528		do.	Control	Control	+	++	.....	+++
	529	do.		do.	do.	+	++	.....	+++
	530		do.	do.	do.	+	++	.....	+++
	531					+	++	.....	+++
	520	6	10–9–30	10–9–30	10 per cent	+	+++		
III	521			do.	Sk. E. D.	+	+++		
	522	months		Control	Control	−	+	+++	
	523		do.	do.	do.	−	+	+++	
	532	5	10–29–30	10–30–30	10 per cent	++	+++		
	539		do.	do.	Sk. E. D.	++	+++		
	537	months	do.	do.	50 per cent	−	++	.....	+++
	538					−	++	.....	+++
IV	533	do.	do.	do.	75 per cent	−	++	.....	+++
	534					−	++	.....	+++
	535				100 per cent	−	++	.....	+++
	536	do.	do.	do.		−	++	.....	+++
	540			Control	Control	−	++	+++	
	541		do.	do.	do.	−	++	+++	

TABLE II
(Steenbock Diet #2966)

Group	No. of Animal	Age	Diet	Date of Fracture	Date of Radiation	Dosage	Callous Formation after:		
							3 Weeks	4 Weeks	5 Weeks
	501	9	Steen-	9–17–30	9–17–30	10 per cent	+	++	+++
	502	weeks	bock			Sk. E. D.	+	++	+++
	504		#2966				+	++	+++
V	505						−	+	++
	506	do.	do.	do.	Control	Control	−	+	++
	507						−	+	++

thymus extract gives better results with increasing years. Stoeltzner also demonstrated that the thymus gland remains active during the life. Dehmel found that implantation of thymus of eight months old rats still has a stimulating effect on young animals.

The results of our experiments prove that *x*-ray radiation with small doses is stimulating for thymus substance in fully devel-

FIG. 3A. FIG. 3B.

FIG. 3. Experiment IV.

A. Radiated animal. Fractured Oct. 9, 1930. Radiated, 10 per cent, Oct. 9, 1930. *X*-ray taken Oct. 27, 1930.
B. Control. Fractured Oct. 9, 1930. *X*-ray taken Oct. 27, 1930.

FIG. 4A. FIG. 4B.

FIG. 4. Experiment V.

A. Radiated animal. Fractured Oct. 29, 1930. Radiated, 10 per cent, Oct. 30, 1930. *X*-ray taken Nov. 12, 1930.
B. Control. Fractured Oct. 29, 1930. *X*-ray taken Nov. 12, 1930.

oped animals. The experiments with the high dosage confirm Milani's findings and show that 25 per cent is the limit for the stimulating dose. A higher dose is destructive. Quicker healing is apparently produced by an increased calcium supply to the fractured bone. The animals which were deprived of calcium by the Steenbock diet required a more prolonged time for healing. And still the influence of radiation is apparent. This reaction very likely consists in an augmented faculty of the bones to store up calcium. This confirms the observation that animals deprived of their thymus glands are not as well able to store calcium in their bones.

Our experiments therefore show that the functional stimulation of the thymus increases the affinity of the bones for calcium and favors the healing of fractures. The *x*-ray pictures illustrate the experiments in their various stages.

It is quite evident that *x*-ray radiation in small doses may be applied in cases of delayed healing of fractures, which are mostly caused by a disturbance in the intermediary metabolism.

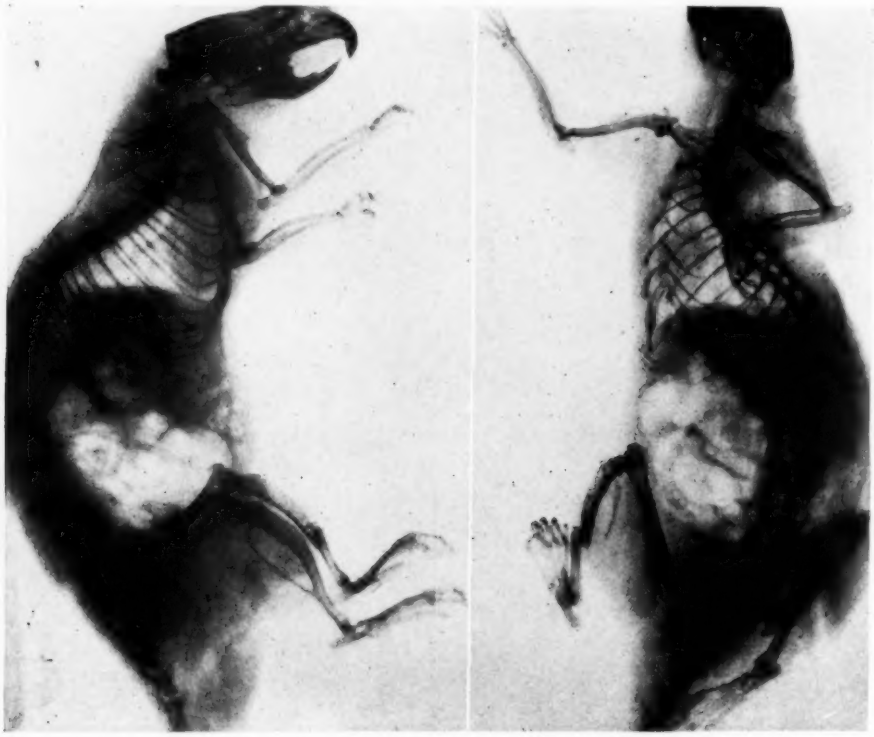

Fig. 5a. Fig. 5b.

Fig. 5. Experiment v.

A. Radiated animal. Fractured Oct. 29, 1930. Radiated, 50 per cent, Oct. 30, 1930. *X*-ray taken Nov. 12, 1930.
B. Control. Fractured Oct. 29, 1930. *X*-ray taken Nov. 12, 1930.

CONCLUSIONS

1. *X*-ray doses of 10–25 per cent have a stimulating effect on the thymus gland of young and old rats.
2. Artificial fractures show a quicker repair after radiation of the thymus than those of control animals.
3. The hyperactivity of the gland results in an increased affinity of the bones to calcium.
4. Small *x*-ray doses may be applied to the thymus in cases of delayed healing of fractures in human beings.

[For References see p. 205].

RETROPERITONEAL APPROACH IN SUBPHRENIC ABSCESS*

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WHEN the operative mortality rate for any surgical disease remains consistently high, suspicion points toward some inadequacy in the procedures employed. Subphrenic abscesses have long been outstanding among this group of diseases. Various reports have shown mortalities of from 32 per cent to 66 per cent in operated cases. In most of these cases the transpleural or transperitoneal routes of approach were used in draining the abscesses and death was often due to rapidly following empyema or general peritonitis. Then in 1923 Nather and Ochsner described a technique for extraperitoneal drainage of the subphrenic spaces, designed to avoid contamination of the major serous cavities. It is the purpose of this paper to present some personal experiences with this method, together with a report of recent results obtained by other members of the Southern Surgical Association. These results show beyond a doubt that the Nather-Ochsner operation has been a most valuable contribution to the science of surgery and that the use of this operation, wherever possible, will materially diminish the number of fatalities due to subphrenic abscess.

Recent articles by Ochsner, McNamee, Elkin and others have given detailed consideration to the anatomical, pathological and clinical aspects of the disease under discussion. However, a brief review of some of these points will tend to emphasize the principles involved in the extraperitoneal operation.

In the first place, the anatomical relationships of the structures underlying the diaphragm are of prime importance. The subphrenic region is best considered from a surgical standpoint to include that portion of the abdominal cavity between the diaphragm above and the transverse colon below. This is primarily divided by the liver into suprahepatic and infrahepatic areas. The suprahepatic area is secondarily divided into four spaces by the reflections of the peritoneum from the under surface of the diaphragm on to the superior surface of the liver known as the falciform and coronary ligaments. To the left of the falciform ligament the backward course of the left prolongation of the coronary leaves a single space on that side. To the right of the falciform ligament there are three spaces produced by the separated leaves of the right prolongation of the coronary ligament. These are a small posterior space behind the posterior leaf, a large anterior space in front of the anterior leaf, and a retroperitoneal space between the leaves. This small posterior space and the retroperitoneal space are of the greatest clinical importance. In a series of 78 cases of subphrenic abscess Fifield and Love reported 31.7 per cent occurring in the right posterior space and 25.6 per cent in the retroperitoneal, 57.3 per cent in the two spaces.

The infrahepatic area is divided by the round ligament and the ligament of the ductus venosus into right and left spaces. The left inferior space is further divided into anterior and posterior spaces by the lesser omentum. The left posterior space is the lesser peritoneal cavity. Abscesses of the infrahepatic spaces occur less frequently than those above the liver, and often in combination with them.

Infection localizing in the subphrenic region does not always proceed to the point of suppuration and abscess formation. Probably more than half of such

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infections heal spontaneously and often their existence may never be suspected. Old inflammatory adhesions between the diaphragm and the superior surface of the liver or in the infrahepatic region are frequently encountered during abdominal explorations or at autopsy. These are definite evidences of healed subphrenic infections.

The source of infection is in the main some suppurative process within the abdominal cavity. Acute perforated appendicitis is most often to blame. Subphrenic abscess formation can also follow simple acute unperforated appendicitis. Perforated gastric or duodenal ulcers follow appendicitis closely, and infections of the gallbladder and bile ducts are next in order of frequency. Hydatid cysts, pancreatitis, splenitis, renal infections and other intra-abdominal conditions may be causative factors. The path of infection from all these lesions is either by direct extension of the organisms or through the retroperitoneal lymphatics.

Infecting organisms may be carried by the blood stream from lesions outside the peritoneal cavity. Such sources are carbuncles, osteomyelitis, respiratory infections, and others.

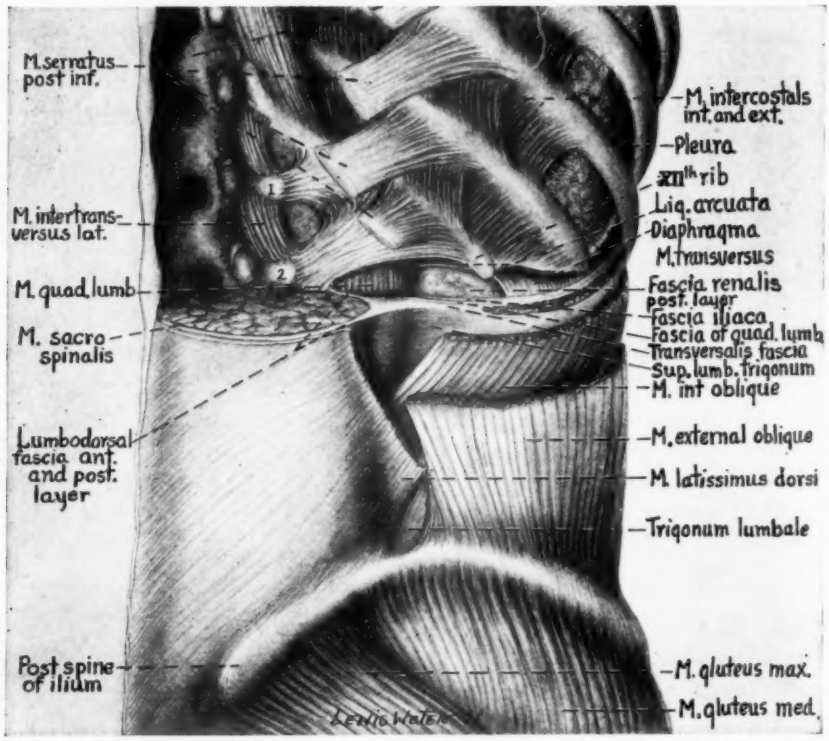

FIG. 1. Dissection showing relations of muscles of lumbar region to approach for retroperitoneal operation for subphrenic abscess. Slightly from right side. (From Dept. of Med. Art, Baylor Univ. Med. School.)

Of 346 cases brought to my attention through personal communications with 105 members of the Southern Surgical Association, the sources of infection were as follows:

	Cases	Percentage
APPENDICITIS	187	54.0
RUPTURED VISCUS (Stomach, Duodenum, Gall Bladder)	81	23.4
MISCELLANEOUS (Acute pancreatitis, Renal infection, Liver abscess, Resection of intestinal malignancy, Splenectomy)	59	17.1
EXTRA-ABDOMINAL LESIONS (Influenza, Lung abscess, Empyema, Septic abortion, Acute salpingitis, Cesarean section, Osteomyelitis, Furunculosis)	19	5.4

Early diagnosis of subphrenic infection is extremely difficult. Even a large accumulation of pus in this region may escape detection because the symptoms are often vague and the signs misleading. The condition should be suspected in any patient who has been recently treated for a suppurative lesion within the abdomen and in whom signs of infection persist or return even after a period of several months. This suspicion is strengthened by the appearance of soreness and localized tenderness in the right flank, along the right twelfth rib, or even along the right costal margin. *X*-ray findings are of utmost importance as confirmatory evidence. Fixation and elevation of the diaphragm on the right are the significant features. A gas bubble under the diaphragm develops only late in the disease and its appearance in the *x*-ray cannot be waited for.

When the presence of subphrenic infection is suspected, conservative medical treatment with supportive measures and local application of heat may cause the process to subside. If such measures are unsuccessful, and it seems certain that an abscess has formed, incision and drainage must not be delayed. Risk of contaminating the pleural or peritoneal cavity makes exploratory aspiration an unwise procedure.

Some form of extraperitoneal approach to the abscess cavity is, I believe, the method of choice. With the exception of those few cases where the localization is obviously anterior, the Nather-Ochsner operation offers a safe and rational plan of procedure. One advantage of primary

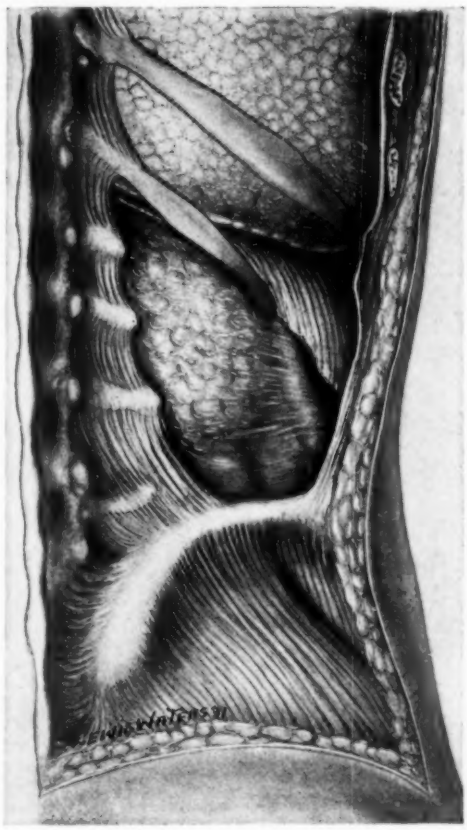

Fig. 2. Dissection showing muscles removed to expose expanded lung, diaphragm and renal fascia. Portion of diaphragm has also been removed, revealing margin of liver and ascending colon through renal fascia and peritoneum. (From Anat. Dept. & Dept. of Med. Art, Baylor Univ. Med. School.)

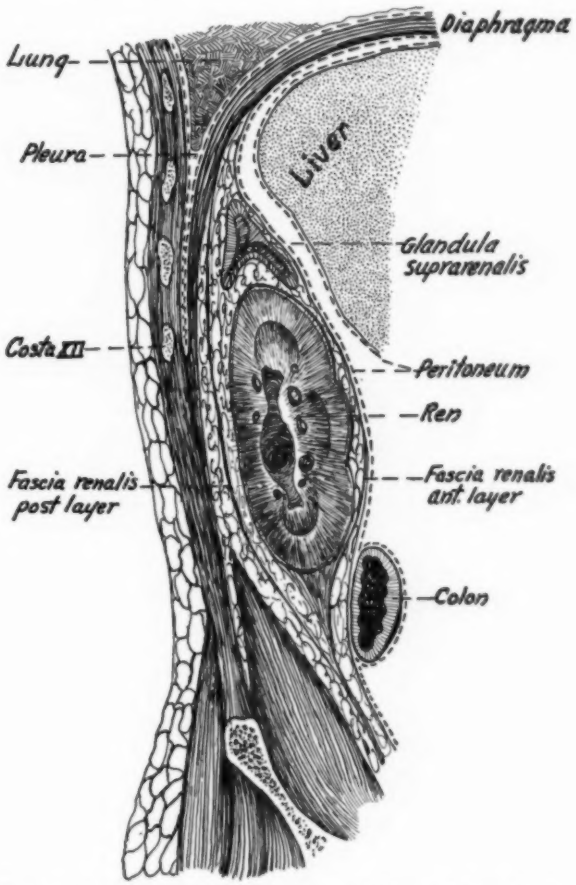

Fig. 3. Sagittal section showing relation of diaphragm to anterior and posterior layers of renal fascia and to peritoneum. (From Dept. of Med. Art, Baylor Univ. Med. School.)

importance is that it can be easily done under local or a combination of local and gas anesthesia.

Fig. 4. Bed of twelfth rib after incision has been made and rib resected subperiosteally. Dotted line shows location of deep transverse incision at level of first lumbar spinous process which is to extend down to renal fascia. (From Anat. Dept. & Dept. of Med. Art, Baylor Univ. Med. School.)

With the patient on the left side, an incision is made over the twelfth rib and the rib resected subperiosteally. The most important step of the operation follows, which is a "transverse incision through the attachment of the diaphragm below the bed of the resected twelfth rib at the level of the first lumbar spinous process." At the bottom of this incision the renal fascia is readily identified by the appearance of the renal fat beneath, and the posterior parietal peritoneum, which is continuous with the renal fascia, is dissected with the finger from the under surface of the diaphragm. Before this dissection has proceeded too far, it is a safe plan at this point to explore the right infrahepatic space with a needle. If no pus is obtained by aspiration, the dissection of the peritoneum from the diaphragm is continued until the supra-

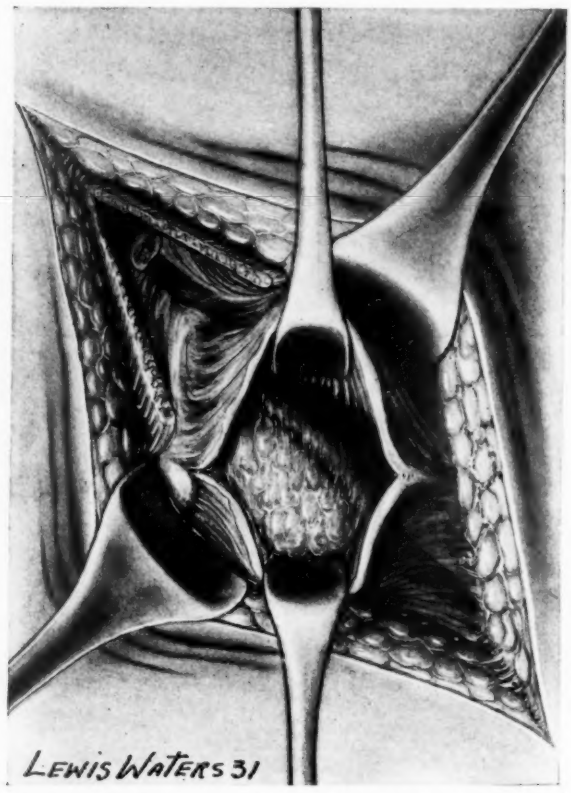

Fig. 5. Exposure of under surface of diaphragm and beginning of its separation from peritoneum. (From Anat. Dept. & Dept. of Med. Art, Baylor Univ. Med. School.)

hepatic abscess is entered, the pus evacuated, and rubber tube drains placed. In case pus is obtained by aspiration in the infrahepatic region, no incision is made until the exploration of the suprahepatic region is completed. If indicated, the pleural cavity can also be explored with an aspirating needle as the costophrenic angle is readily accessible from beneath. If empyema is found it may be drained through the same incision.

Subphrenic abscesses located anteriorly may be also drained extraperitoneally by the use of Clairmont's operation. An incision is made along the costal margin down to the peritoneum, which is then separated from the anterior abdominal wall and the under surface of the diaphragm until the abscess is reached.

I should like to present in some detail 2 cases recently encountered and successfully treated by the Nather-Ochsner operation:

Case I. Z.E.A., aged twenty-one, carpenter, entered the hospital January 31, 1931, complaining of severe pain in the epigastrium, of twelve hours' duration. The abdominal wall was rigid and a diagnosis of perforated gastric ulcer was made. Operation was performed immediately, a perforated gastric ulcer was resected and the defect in the stomach was closed. Convalescence was stormy. On the third postoperative day, pneumonia developed. On the eleventh day when the pneumonia was clearing satisfactorily, signs of acute intestinal obstruction appeared. The incision was re-opened, a band of constricting adhesions divided and a jejunostomy done. The patient began to recuperate rapidly but on about the seventeenth day he complained of pain in the right lumbar region. This pain, together with a slight temperature elevation, persisted. The wound healed and he was allowed to leave the hospital but was kept under close observation. Six and a half weeks after the first operation he was re-admitted with increased pain in the right flank and temperature ranging from 99° to 103°F. *X*-ray pictures showed a shadow at the right lung base suggesting empyema but aspiration of the pleural cavity yielded only a few cubic centimeters of serous fluid. This tended to confirm the suspicion that a subphrenic abscess was present. Nine weeks after the first abdominal operation, the extraperitoneal operation of Nather and Ochsner was done and about 300 c.c. of pus drained from the posterosuperior subphrenic space. Drainage tubes were placed and recovery was rapid. The patient left the hospital three weeks after the last operation. The wound was completely healed in two months and he returned to work.

Case II. J.T.H., aged seventy-nine, lumberman, entered the hospital March 8, 1930, complaining of severe pain in the right inguinal region where he had had a large hernia for many years. Eight days before, he had injured the hernial region by falling over a chair and the pain had been increasing in severity since that time. Two days before admission he began vomiting and was found to have a temperature of 102°F. Nausea, vomiting and fever continued, marked tenderness and muscular rigidity in the right lower adominal quadrant were found and operation was advised. Incision was made above the inguinal canal and a large appendiceal abscess was drained through the hernial sac. After a severe respiratory infection and phlebitis of the right leg, he improved sufficiently to be discharged from the hospital twenty days after the operation. After another four weeks the wound had completely healed. He remained in excellent health except for one severe attack of cold and bronchitis with fever lasting two weeks, until sixteen months after his operation, then he began to complain of pain in the right kidney region and ran a daily temperature elevation of 101°F. He was again admitted to the hospital where the diagnosis of subphrenic abscess was made, based on the pain and tenderness in the right flank and *x*-ray evidence of a fixed and elevated right diaphragm. On July 21, 1931 the abscess was drained extraperitoneally. His recovery was rapid and uneventful, and he is still quite well.

I operated on a third case several years ago, using the transperitoneal approach. This patient died of peritonitis.

One hundred and five surgeons answered my questionnaire concerning their experiences with subphrenic abscesses. Forty-four had no cases to report. Most of these men are engaged in special branches of surgery which do not involve the treatment of abdominal disease. The remaining sixty-one reported a total of 346 cases, of which 333 were operated upon. Three hundred and thirteen of these operations could be grouped definitely under one of three types, i.e., transpleural, transperitoneal or extraperitoneal. In this group there were 87 deaths, or a general mortality rate of 37.9 per cent. Transpleural or transperitoneal operations were used in 275 cases with a mortality of 41.0 per cent.

	Cases	Deaths	Percentage
Transpleural, Transperitoneal and Extraperitoneal Operations	313	87	37.9
Transpleural or Transperitoneal	275	80	41.0
Extraperitoneal	38	7	18.4

The extraperitoneal operation was used in only 38 of the 313 cases. Out of this 38

there were seven deaths, a mortality of 18.4 per cent. This last series is too small to allow any definite conclusions to be drawn. A comparison of the 18.4 per cent mortality with the 41 per cent however is a striking one, and even more striking is the result obtained in the series which Ochsner himself has treated. In this series, 19 patients with subphrenic abscess were operated upon through the extraperitoneal approach and only one death followed, a mortality of 5.2 per cent. As the sound principles involved in the technique of the extraperitoneal approach are more widely recognized, and it becomes more generally employed, I am confident that other series with results equally gratifying will be reported.

SUMMARY

1. Subphrenic abscess is briefly considered from the standpoint of anatomical relationships, pathology, diagnosis and treatment, especially by operation through the extraperitoneal route.

2. The etiology is given in a group of 346 cases treated by sixty-one surgeons.

3. Two cases treated successfully by the extraperitoneal operation are reported.

4. The mortality rates are given for a group of 313 cases treated by transpleural, transperitoneal and extraperitoneal operations.

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GONORRHEAL INFECTION OF THE KIDNEY PELVIS

REPORT OF FOUR CASES*

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GONORRHEAL infection of the kidney is rare.[1] It is not so extremely uncommon for a severe gonorrhea to be accompanied by a pyelonephritis, but this is seldom due to gonococci.[2] However, Barney,[3] in reporting his case which resulted in nephrectomy, stresses the point that undoubtedly many cases pass unnoticed because of very mild symptoms with recovery under palliative treatment.

In most case reports the diagnosis of gonorrheal kidney infection is based upon the finding of gonococci in the urine with an accompanying pyelitis. Birkhaug and Parlow[4] contend that only those cases can be considered authentic which show positive fermentation and serological reactions and they find record of only 4 cases that meet this requirement. Obviously this is impracticable as a clinical routine. Finding gram-negative intracellular diplococci—morphologically gonococci—in urine obtained by ureteral catheterization in a patient with an uncured gonorrhea is evidence of gonorrheal pyelitis. This may further be checked by culture on Löffler's serum agar. If the diplococcus grows on this medium it is not gonococcus. In line with this thought Thomson[5] of London feels that diagnosis of a gonorrheal kidney infection is entirely microscopical, and Sakata[6] contends that demonstration of gonococci by either staining or cultural methods from material obtained from the kidney pelvis or the kidney parenchyma is proof of gonorrheal kidney infection. He finds only 24 definitely proved cases and discards a large number based upon subjective evidence.

Four theories have been advanced to explain possible routes of infection of the upper urinary tract: (1) Albarran and others[7,8] contend that the hematogenous route is the most common. (2) Luys,[9] in his textbook on gonorrhea, leans toward the ascending route, contending that the ureteric orifices in gonorrheal trigonitis are enlarged and gape, and the urine easily flows backward from the infected bladder and finds its way to the kidney. However, when there is no concomitant cystitis, he feels that it may pass through the blood stream. (3) The lymphatic system, as the third possible route, was *apparently* experimentally demonstrated by Sakata[10] as remotely possible. Stanton[11] reports a case which he believes tends to show that it is possible to infect the kidney from the bladder through the lymphatics. The weight of evidence does not support the contention of frequent extension along this route. (4) Lack of sufficient proof at once discards contiguity as the fourth route.

Consideration of the ascending route naturally involves some hindrance to normal drainage in the lower urinary tract, with back pressure, poorly functioning ureteral sphincters and ascending infection.

Hazy or cloudy urine (glass 2 of a two-glass test) may be the only subjective symptom of gonorrheal pyelitis. An occasional dragging weight or very slight tenderness in the kidney region may be present. Symptoms intermediate from this to severe pain in the loins, temperature ranging as high as 103° or 104°F. with definite chills or chilly feeling, may accompany gonorrheal bacteriemia or extensive kidney involvement. Irreparable damage to the kidney and even nephrectomy has been the terminal result of some of these cases. Simmons[12] describes his patient as

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having no symptom referable to the kidney until an injury brought him in for operation. J. K. Way,[13] a few days after examination and hospitalization of his patient for acute gonorrhea, opened a renal abscess due to extension of this process to the kidney. After a period of six years' quiescence in Lehr's[14] case, there was cloudy urine and terminal hematuria. On study the cause was found to be that of gonorrheal pyelitis.

Three of the cases presented below are mixed infections and in the fourth only the gonococcus was found. The question whether gonorrheal infection of the kidney is primary or superimposed upon a previous infection with the ordinary pyogenic organisms is of more than academic importance. Enough cases of pure gonorrheal infections of the kidney have been reported to establish definitely that gonococci may attack a previously uninfected kidney, but there is no proof that such kidneys were not more susceptible for reasons of increased intrapelvic pressure, due to slight mechanical hindrance to drainage of one kind or another, or other damage to the kidney by back pressure, sometimes unilateral. The basic treatment, however, is the same in either instance: relief of stasis and obstruction or other hindrance to drainage. Of secondary consideration is the use of bactericidal substances.

Case 1. V. I. M., male, thirty-seven years of age, married eight years, wife never pregnant, occupation: truck driver.

August 11, 1930 he came to the office complaining of pain in the left testicle. For the past ten years he has had periodic attacks of dull grabbing pain in the loins, lasting a few days. No attention was paid to it. A haziness of the urine was also noticed for which he received treatment. In 1921 he had an acute epididymitis on the left side. He was unaware of an urethral discharge preceding it and the cause was unknown to him. It apparently cleared up completely in two weeks. He was at no time bedridden.

July, 1928 he contracted his first and only attack of gonorrhea. The gross discharge disappeared in six weeks; no complications. The pains in the kidney regions became more accentuated. In February, 1929, a double epididymitis developed which kept him in bed for five days. The right side cleared up in about a week. The left side, however, remained slightly painful and tender to date. The patient remarked that his urine has been cloudy since the initial infection and he now urinates every two hours during the day and three times during the night. He has no dysuria and has never had hematuria. He has no digestive or nervous complaint.

His previous history tells us that he had mumps in his boyhood without complication and influenza in 1918 without sequela. Family history is irrelevant.

The man is well nourished, mentally clear, shows no signs of acute illness or distress. Blood pressure is 120/84. Temperature and pulse are normal. Examination of the patient, exclusive of his urinary tract, is essentially negative.

Urinary System: There is no urethral discharge. The left globus major is perhaps a trifle enlarged, but distinctly not a tuberculous epididymitis. Urine is hazy, neutral, specific gravity 1.005; does not clear with acetic acid, is negative for sugar, faint trace of albumin, and there is a small thick sediment. Microscopic examination shows very many pus cells with an occasional R. B. C., many gram-negative intracellular and a few extracellular diplococci. Flat *x*-ray film is negative for calculus. There is no tenderness in the kidney regions.

Systematic treatment over a considerable period failed to bring about a cessation of pyuria. On February 25, 1931 a left vasectomy was performed. On March 17, 1931, because of persistence of symptoms, cysto-urethroscopic examination was done. The bladder mucosa and ureteral mouths were normal in appearance. Urinary drip was satisfactory. Pyelograms were taken.

Just what led to the suspicion of kidney infection and just what finally justified ureteral catheterization? The history of a man with a slight discharge only upon squeezing the urethra, pyuria with gonococci always present in both glasses of urine, with cloudiness in both always to about the same extent; with a prostate revealing no gross infection by palpation and the prostatic juice showing only a very small amount of pus upon micro-

scopic examination, no dysuria or evidence of active seminal vesical infection, no stricture and no relief nor any reaction from the passage of full sized sounds, necessitated locating the focus. Finally examination with a Stern cysto-urethroscope revealed a few hypertrophic lesions in the posterior urethra adjacent to the bladder neck. This, however, was not sufficient to account for the cloudiness of glass 2, its pus and the gonococci content. Accordingly, through a No. 21 McCarthy cystoscope, No. 4 ureteral catheters, occluded with pins, were inserted and gave us the urine containing gonococci. Later No. 7 catheters were used. The catheterized specimens give the following findings:

Left side: Sediment small. Few R. B. C., few pus cells, several groups of intracellular gram-negative diplococci (morphologically gonococci) and a moderate number of extracellular (grouped and scattered). Also very few gram-negative bacilli, grouped.

Right side: Small sediment, very occasional R. B. C., considerable number of pus cells, moderate number of intracellular gram-negative diplococci (morphologically gonococci) and many extracellular (grouped and scattered). Several groups of very small gram-negative bacilli.

Instillation of a 1:250 solution of silver nitrate was repeated four times. Pyelograms showed moderate hydroureters.

Diagnosis: Pyelitis of gonorrheal origin; hydroureters.

Patient is still under treatment.

Case II. L. E. F., female, aged twenty-eight, single, occupation: stenographer.

Her complaint on October 14, 1925, was frequency and dysuria with a most severe pain one or two minutes after urination. She voids twice at night. This complaint began about seven months previously with terminal burning. Close questioning also elicits a history of a vaginal discharge, undoubtedly gonorrheal. She was treated by another physician with bladder irrigations of permanganate of potash and tampons which markedly lessened the discharge but only moderately did it improve the urinary symptom.

Physical examination reveals an urethral stricture which passes readily a No. 8 Hegar catheter. The catheterized bladder specimen of urine is cloudy, acid, heavy ring of albumin; microscopically there are many pus cells, an occasional R. B. C., and considerable number of gram-negative bacilli.

Cystoscopic Examination: Bladder mucosa and ureteral mouths appear normal. No. 7 ureteral catheters were passed to both pelves. The urine from the left kidney was cloudy, weakly alkaline, moderate amount of sediment; microscopically there were a moderate number of pus cells, few R. B. C., and moderate number of gram-negative bacilli. That from the right kidney appears cloudy, reaction alkaline, small sediment; microscopically no pus, an occasional R. B. C., small deposit amorphous phosphates and no organisms.

Phenolphthalein: Right appeared in five minutes and 24 per cent was passed in twenty minutes. Left also appeared in five minutes, and the following twenty minutes gave 16 per cent. There was no bladder leakage. No change in findings up to July 9, 1926. The urine from the left kidney this time was clear, has a small sediment; microscopic examination showed a considerable number pus cells, few R. B. C., very few gram-negative bacilli and an occasional group of intracellular and extracellular gram-negative diplococci. On August 30, urethral smear showed many pus cells, and considerable number of intracellular and extracellular gram-negative diplococci. Under bladder and cervical treatment, the gonococci disappeared from urethra and for eight months no diplococci were found in either bladder urine or in smears taken from the urethra. June 26, 1928 the left kidney specimen showed numerous gram-negative diplococci. Treatment during this period consisted of ureteral dilatations and kidney lavages. Flat plate shows a calculus in the left kidney. August 7, 1929, a nephrolithotomy was done and the calculus extracted. Since then there has been a reappearance of gram-negative bacilli but once.

Case III. Negro, male, aged thirty, admitted to the Los Angeles General Hospital September, 1918.

He complained of marked dysuria and frequency, pain and tenderness over right costovertebral angle. Afternoon temperature ranged between 103° and 104°F. Urine was cloudy and microscopically contained many pus cells and some R. B. C.

Cystoscopy was exceedingly distressing, so much so that the patient left the hospital immediately. Base of bladder on the right,

including trigone and right ureteral orifice, was intensely injected, edematous and inflamed. Right kidney specimen brought a thick purulent urine. This specimen disclosed a great number of gram-negative intracellular diplococci, morphologically gonococci.

Case iv. W. T. E., male, aged fifty-two, single, occupation: elevator operator.

Patient was admitted to the Los Angeles General Hospital April, 1918, with a history of dull ache in the left costovertebral region, extending to the corresponding area of the abdomen. The early part of this month he experienced a sudden sharp pain in this region which continued for two or three days as a less acute ache. He had incontinence of urine and feces at this time. He noticed that the urine was cloudy but there was no hematuria, nor did he notice any calculus or gravel in it. In the previous March he had a similar attack which lasted two days.

He had gonorrhea first at twenty-two, which lasted six weeks and no complications developed. In 1910 he had it again, lasting two months. This was followed by generalized rheumatism for six months. In 1916 he had gonorrhea a third time, lasting one year, which was again accompanied by rheumatic pains all over the body. Since then his urine has been cloudy most of the time. He also has an uncomfortable tickling in the perineum.

Examination of the Urinary Tract: Urine is cloudy, heavy ring of albumin, no sugar; microscopically numerous intracellular gram-negative diplococci, and few gram-positive staphylococci. Cystoscopic examination: Bladder shows no pathology. The left kidney is non-functioning. Smear from the sediment of urine collected from this kidney discloses many gram-negative intracellular diplococci, morphologically gonococci; also gram-positive staphylococci. Radiographic study disclosed a large left infected hydronephrosis with a small calculus acting as a ball valve. Function of right side normal; no pus. Pyelogram normal. Nephro-ureterectomy was done May 1, 1918. The kidney, full of pus, burst on the table. Patient made satisfactory recovery and urine has remained clear to date.

SUMMARY

The finding of gram-negative intracellular diplococci, morphologically gonococci, in a specimen from the kidney pelvis is the most important single factor in the diagnosis. Culture is too delicate a procedure to be expected routinely. Sometimes even formaldehyde or other agents used in sterilizing ureteral catheters may so affect the bacteria that no growth results. Contamination may overshadow and force the gonococci out of the picture. Culture of gonococci on Schwartz media from the urethral pus in an ordinary acute case of gonorrhea is often successful in the hands of the highest class of clinical laboratory worker, but one must be highly optimistic to expect a high percentage of positive cultures in cases of mixed infections. Case records in the literature fail to disclose any case of micrococcus catarrhalis infection that could well be mistaken for gonorrhea if the ordinary precautions and conscientious efforts, coupled with adequate experience in staining and examining smears of urethral pus, be exercised; while infection of the urinary tract by the meningococcus, unaccompanied by the clinical picture of meningitis, is such a remote possibility as to leave it out of consideration.

Of the cases presented, two underwent operative procedure, one nephrectomy and the other nephrolithotomy. One is still under treatment. Diagnosis was established microscopically previous to operation.

Considering the advanced cases which come to the urologist, it is not at all surprising that a goodly number of these kidney infections come to operation. Subjecting a patient with acute or subacute gonorrhea to ureteral catheterization is, generally speaking, contraindicated. However, in cases of long-standing gonorrhea with the second glass of urine of a two-glass test as cloudy as glass 1, containing a large amount of albumin, and after the lower genitourinary tract is considered excluded from the standpoint of sufficient pathology to account for these findings, especially when accompanied by a feeling of tightness, dragging sensation or pain in either costovertebral angle, one should be led to seriously consider ureteral catheterization.

For the purpose of this examination, only the smallest and most flexible catheter with a pin in the outer end, a No. 4 size, used through a small cysto-urethroscope, should be employed. Under such circumstances the danger of implanting gonorrheal infection in the kidney pelvis is remote. Moreover, an unfavorable soil is probably responsible for its clinical rarity. Gonococci flourish mostly on columnar epithelium.

For permission to publish these cases I am indebted to Dr. Robert V. Day.

DISCUSSION

Dr. Anders Peterson: Considering the great prevalence of gonorrheal infection in both sexes, we are at once impressed with the rarity of kidney involvement. That the infection takes place through the blood stream seems to me the most logical conclusion. We know that gonorrheal bacteriemia, joint invasion, endocarditis, etc., must take this route of invasion. The kidney undoubtedly possesses a high immunity and thus escapes involvement, though it is often exposed. No specific treatment has been evolved, but it is quite generally agreed that silver nitrate solution is the application of choice.

Dr. D. Buie Garstang: Gonorrheal infection of the kidney is indeed rare, not a great many cases have been reported to date. I have seen 2 cases which I am satisfied were positive. The first, about fifteen years ago, occurred in a young man who sought treatment for a typical acute posterior gonorrhea. A few days after coming under observation he complained of severe pain in the right kidney region accompanied by fever to 104°F. The pain was so severe that we decided to catheterize the ureter in spite of the urethral infection, and obtained a very purulent urine loaded with gram-negative intracellular diplococci. The renal pelvis was lavaged with 10 per cent argyrol. The renal pain was relieved and did not recur. We were rewarded for our efforts with a typical gonorrheal epididymitis, which subsided in about ten days, but the patient, relieved of his urethral as well as the renal pain, refused further treatment and disappeared.

The second case occurred in a young woman in April, 1923, one and a half years after a gonorrheal infection, following a criminal assault, from which she had apparently made a good recovery. Her first symptom of renal infection was sharp pain in the left kidney accompanied by moderate frequency and urgency of urination. The bladder urine was very purulent with numerous gram-negative intracellular diplococci. Catheterized urine from the left kidney showed the same. Dr. Zeiler made several attempts to culture the organism without success, and concurred in the opinion that we were dealing with the gonococcus. She was treated till July by pelvic lavage with 10 per cent argyrol and 1 per cent silver nitrate weekly. The pus and diplococci gradually disappeared. On July 5, 1923 the bladder urine showed much pus and colon bacilli; no diplococci were found. The urine from the left kidney showed a few colon bacilli, very little pus and no diplococci. She was treated until September, the urinary sediment was frequently examined, the colon bacilli gradually disappeared, cocci were never found. Her highest temperature was 99.4°F. She was again seen in December, 1923, said she was feeling fine and refused to permit examination to determine if infection still existed.

I think Dr. Kessler has been fortunate in seeing so many cases of this infrequent kidney infection, and I agree with him, that until we are better able to culture the gonococcus, we will have to consider those cases gonorrheal in which we find an organism with its morphological and staining characteristics and resistant to ordinary culture methods.

Dr. Kessler, *closing:* Where obstruction to the urinary stream, either at the kidney pelvis outlet or in the ureter itself, is present and satisfactorily corrected, a cure is usually attained. Cases of gonorrheal pyelitis reported in the literature as "well" practically all had been treated with radical procedures. However, where there is no apparent obstruction symptomatic treatment is often prolonged and disappointing.

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[For remainder of References see p. 246.]

PUERPERAL GYNECOLOGY*

INCLUDING GYNOPLASTIC REPAIRS OF OLD LACERATIONS, PRIMARY CYSTOCELE, AND UTERINE FIXATION AT OR SHORTLY AFTER CHILDBIRTH†

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INTRODUCTION

REALIZING that very few women are able to go through labor without some resultant pathology, and that most of these suffer years of invalidism because of the difficulty of leaving their domestic duties and returning to the hospital for repairs, I attempted, in 1916, a procedure which I had been planning for a long time, i.e. to repair old as well as new lacerations of the genitalia shortly after childbirth.[1] In spite of my training in the conservative school, I was unable to accept the theory that this was impractical because of the edema, congestion, and friability of the tissues. The difficulty of recognizing the different anatomical layers was emphasized. The presence of the lochia and the dangers of infection were also feared.

I would like to mention here that some years after reporting my first series of cases, I learned that Dr. F. H. Stuart in 1906,[2] and Dr. A. A. Hussey[3] in 1916, both of Brooklyn, reported work along this line, limiting themselves to the repair of the cervix and perineum. DeLee[4] told me that he had tried to do some repair work in 1898. My work was done independently and without any knowledge of earlier attempts and includes many more types of operations. (Table 1.)

At first these repairs were done a week after delivery. The results were so satisfactory that the time between the delivery and repair was gradually shortened and in 1920[5] I reported two cases that were satisfactorily repaired immediately after the expulsion of the placenta.

Since that time, encouraged by the study of the end results over a period of many years, it has become routine procedure for the obstetrical staff of Mt. Sinai Hospital of Cleveland to repair practically all old and new lacerations immediately or within a week after delivery.

In a series of 1326 cases, 1097 or 82.7 per cent were operated upon immediately and 207 or 15.6 per cent were operated upon between the third and sixth days. One patient who had refused operation changed her mind and was operated on the fourteenth day post-partum.

Immediate operation following delivery has many advantages over delaying the repair for several days.

(1) The patient is spared the added shock and fright, the double anesthesia and the second charge for the operating room.

(2) Her stay in the hospital is not prolonged.

(3) The infant does not miss any feedings.

(4) There is less danger of infection and morbidity. It has been proved that bacteria multiply very rapidly in the uterus and the vagina, beginning the third day post-partum.

(5) The cervix can be pushed toward the introitus immediately after delivery without much force, due to the complete relaxation of the supporting ligaments and the vaginal canal.

(6) The tender skin and mucous membrane are saved the irritation from repeated sterilization from iodine, etc.

(7) The tissues might be somewhat more edematous but are not quite as

* This is the first time that this term has been applied to gynoplastic repairs after deliveries.

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friable as several days later. With experience it is possible to recognize the anatomical structures, the amount of relaxation present and the extent of repair necessary.

Many do not examine the cervix on account of the danger of carrying in an infection, closing the cervix too tightly or the fear of lacerations or complications

Table 1

TYPES OF OPERATIONS

	1922	1923	1924	1925	1926	1927	1928	1929	Total
C	...	1	1	...	4	...	...	...	6
T	29	25	26	20	16	17	8	6	147
P	43	46	43	58	63	43	59	34	389
3rd°.P	...	...	...	...	...	1	1	1	3
H	3	2	8	7	9	4	5	2	40
T.H	...	...	...	...	...	...	4	...	4
T.P	71	53	79	45	47	60	65	39	459
T.C	1	1	2	1	...	1	...	...	6
T.C.P	7	11	20	10	7	8	7	17	87
T.P.H	4	1	9	9	3	6	5	7	44
T.C.H	...	1	3	...	...	...	...	...	4
T.C.P.H	...	6	5	1	5	1	...	4	22
T.P.U	...	1	...	...	...	...	...	...	1
C.P.H	1	3	4	...	1	...	1	1	11
C.P	10	4	1	8	8	1	3	4	39
A.C.P	...	3	2	...	1	...	...	...	6
A.C.P.H	...	2	1	...	...	...	1	...	4
A.C	...	...	1	...	...	...	...	...	1
P.H	...	1	2	3	8	7	5	6	32
Amp.Ce.P	...	...	...	...	1	2	1	1	5
Vag.Fix	...	...	...	...	...	3	...	2	5
Caut.Ce.C.P	...	...	...	...	...	1	3	2	6
Caut.Ce.T.P	...	...	...	...	...	...	1	...	1
Bart.Cyst	...	...	...	...	...	1	1	1	3
Rect.Vag.Fist.3rd°.P	...	...	...	...	...	...	1	...	1
Total	169	161	207	162	173	156	171	127	1326

C., Cystocele. T., Trachelorrhaphy. P., Perineorrhaphy. H., Hemorrhoidectomy. U., Umbilical hernia. Amp.-Ce., Total amputation of cervix. A.C., Partial amputation of cervix. Vag.Fix., Vaginal fixation. Caut.Ce., Cauterization of cervix. Rect.Vag.Fist., Rectal vaginal fistula. Bart.Cyst, Bartholin cyst.

The repair of old lacerations may be delayed for one or more of the following reasons: first, after a very long labor or difficult delivery, additional shock or hemorrhage might be inadvisable; second, the presence of a suspected infection would certainly be another reason for waiting; third, operation is often delayed on patients who enter the hospital too late for complete preparation; fourth, if the operator lacks skill and experience in working rapidly, it might be advisable to postpone the operation rather than expose the patient to too prolonged anesthesia, shock and hemorrhage at the time of delivery.

occurring at subsequent deliveries. Personally, I feel that a torn cervix, regardless of how small the tear, rarely becomes normal in contour; it is always a source of danger as a focus of infection and as a seat for malignant degeneration. What was considered radical and dangerous a generation ago can now be done in safety, due to the remarkable progress that surgery has made and the improvement in hospital and nursing technique. Time, experience and improved methods have shown the comparative safety, advisability and benefits of this work to the mother, the family and the community. The mother leaves

the hospital in the best possible physical condition after her confinement, she is saved chronic invalidism and subsequent

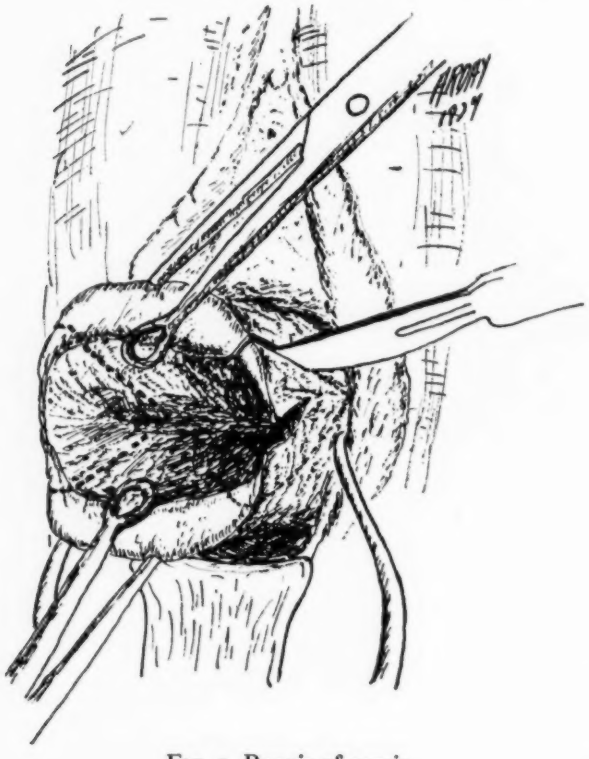

Fig. 1. Repair of cervix.

operations with the accompanying pain and expense.

INDICATIONS

There are very few women who do not develop some pathologic condition as a result of childbirth. In a series of over 5000 obstetrical cases admitted to the Mt. Sinai Hospital of Cleveland, from 1923 to 1930, 38.5 per cent of the multiparae were operated upon for old lacerations.

The remaining unoperated cases consisted of primiparae, cesarian sections, complicated deliveries precluding the repair work, multiparae who had been repaired before and were treated as primiparae, and some others who refused to be operated upon.

The extent of the lacerations or relaxation do not determine the operation. No laceration is small enough to be neglected. Nature rarely cures even the smallest satisfactorily, and if neglected, it may cause numerous gynecological complaints and disabilities.

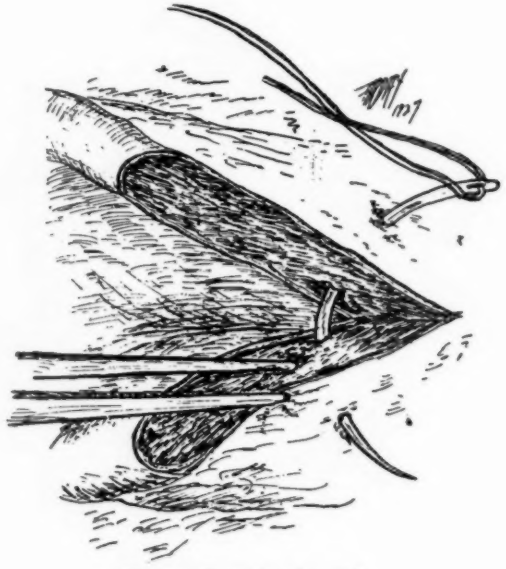

Fig. 2. Repair of cervix.

First, there are those of the cervix, which may result in eversion and hypertrophy. This may be the seat of an ascending infection into the uterosacral ligaments and the bases of the broad ligaments, into the walls of the uterus and into the endometrium. Infected Nabothian follicles, leucoplakia and cancerous degeneration frequently follow.

Second are lacerations of the anterior vaginal wall which may produce a cystocele or a urethral prolapse (so called urethrocele). The former, regardless of its size, may be a cause of attacks of trigonitis, cystitis, and ascending infections into the kidneys. The latter may result in a prolapse of the urinary meatus and urethral caruncle.

Third, lacerations of the posterior vaginal walls and perineal body are followed by rectocele, prolapse of the uterus and of the rectum. Hemorrhoids are frequent end results.

All these conditions lead to the well-known gynecological complications and complaints.

Another indication which is often overlooked is the effect of the patient's dis-

abilities in the marital and sexual relations. Regardless of their status in society, many men have become estranged from

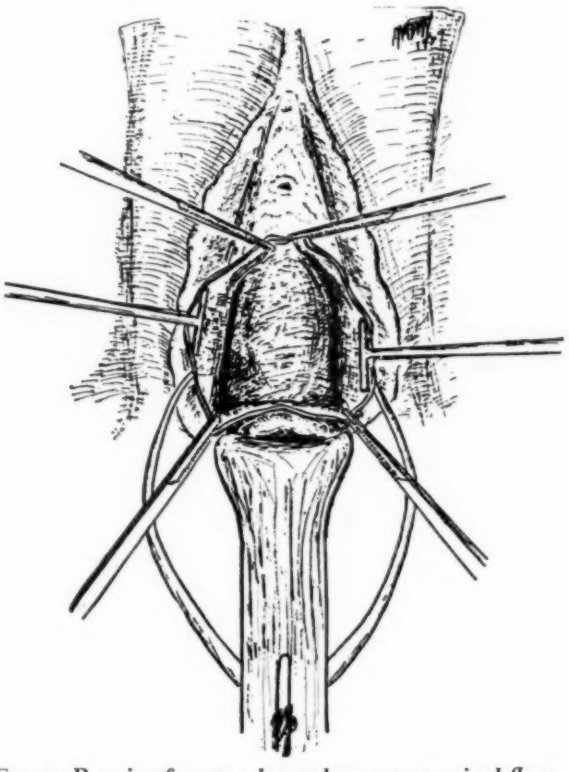

Fig. 3. Repair of cystocele: T clamps on vaginal flaps.

their wives who were suffering from relaxation, leucorrheal discharge or other gynecological disabilities which followed childbirth. Many couples have volunteered the statement that since the last childbirth and repair relations have been resumed with very happy and satisfactory results.

Although there has been a generally accepted theory that a woman should go through her child-bearing period before submitting to gynoplastic repairs, or wait until the menopause, I have maintained that it is unwarranted and often disastrous to follow this principle. Our youngest patient was eighteen years old, para ii, who had a badly lacerated cervix, cystocele and rectocele as a result of her first confinement. We were able to cure these at the subsequent delivery with very little risk. Should she have been compelled to suffer for twenty or more years until the menopause? Besides, how can we tell when the patient will stop reproduction?

Five hundred and five of 1326 cases were

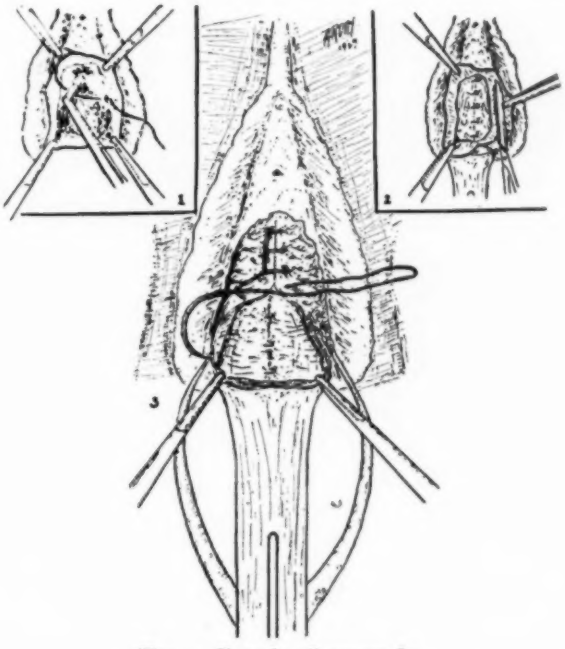

Fig. 4. Repair of cystocele.

1 and 2. Suture of pubovesical fascia, making a new floor for bladder.

3. Suture of mucosa after cutting away excess tissue.

para ii, showing that the repair of many primiparae was either neglected or faulty.

In our series, we have found that the operative deliveries are not contraindications and that the repair of old as well as new lacerations can be done after any type of delivery providing that the correct technique is used.

This is well illustrated by Table II:

Table II

Types of Deliveries Followed by Gynoplastic Repairs

(Jan. 1922 through Dec. 1929)

Precipitate	18
Spontaneous	686
Low forceps	380
Mid forceps	82
Version and extraction	76
Breech	25
Manual dilatation of cervix: vers. & extract.	18
mid forceps	6
low forceps	8
Macerated fetus, low forceps	1
Scanzonian maneuver, mid forceps	20
Bag, breech	2
Twins	3
Total	1326 cases

In many cases, low forceps were applied to help the fetal head past the pubic arch and to shorten the time of labor and delivery.

Subsequent deliveries are not usually complicated by the presence of scar tissue from previous repairs. If any lacerations occur, they are immediately repaired as in primiparae. Table III shows 3 cases of a large series of patients who were delivered after extensive repairs at previous confinements.

TECHNIQUE FOR LABOR AND IMMEDIATE REPAIR

There are certain prerequisites necessary for the success of the delivery and repair. The first to be considered is the prenatal care which should include a thorough history and physical examination. Fortnightly observation of the growth and position of the fetus and examination of the urine, blood pressure and weight should be made. The condition of the breasts, thyroid, and bowel movements are also observed. Bad teeth, tonsils, cervical infections, etc., are corrected if possible. Instructions are given about proper clothing, abdominal support and diet. Abstinence from intercourse during the last months of pregnancy is also advised. Old lacerations, hemorrhoids and other abnormal or pathologic conditions are noted for future consideration.

The delivery should take place in a well-regulated hospital where the strictest asepsis and antisepsis prevail. The obstetrician should have gynecological experience so that he can recognize the abnormal

TABLE III

Name	Para	Date 1st Ex.	Delivery	Repair	Subsequent Examination	Remarks	Subsequent Deliveries	Later Exam.
M. H.	ii	2/10/21 Rel. +++ C. ++ R. +++ Lac. Ce.	6/23/21 Knee presentation. 13 lb. baby	T.C.P.	3 months – – – well healed		4/18/24 L.F. P.H.	18 mos. later in good cond.
J. K.	iv	10/2/20 Rel. ++ C. + R. ++ Lac. Ce.	11/1/20		5 weeks ± – ± good cond.	Aet. 44 years	9/15/23 Normal delivery. P.H.	5 mos. later genitalia in good cond.
R. L.	vii	4/21/19 Rel. ++ R. ++ Lac. Ce.	6/10/19 Normal	T.P.	5 years – – good cond.	Aet. 42 years	3/10/24 Normal delivery.	3 mos. later genitalia in good cond.

Rel., Relaxation. C., Cystocele. R., Rectocele. Lac.Ce., Lacerated cervix. T., Trachelorrhaphy. P., Perineorraphy. L.F., Low forceps. H., Hemorrhoidectomy.

CONTRAINDICATIONS

There are few contraindications besides those generally spoken of in surgery. The presence of a known or suspected infection, extreme weakness, bad heart or kidney condition, the presence of a respiratory disease which prohibits a prolonged anesthetic, large vulvar varicosities, marked edema, post-delivery shock or hemorrhage, phlebitis, or a full stomach may be considered as temporary contraindications. Many of these patients can be prepared for operation either by entrance to the hospital several days before the delivery or the operation may be delayed until a favorable time.

from the normal. Proper light, assistants and instruments are paramount.

Assuming that the foregoing requirements are fulfilled, the patient enters the hospital as soon as any spotting or bleeding occurs, if the membranes rupture before labor begins or when labor pains occur about ten minutes apart. This allows ample time for examination and preparation. Only rectal examinations should be made during labor. The dilatation of the cervix and the descent of the presenting parts can be readily determined in this manner.

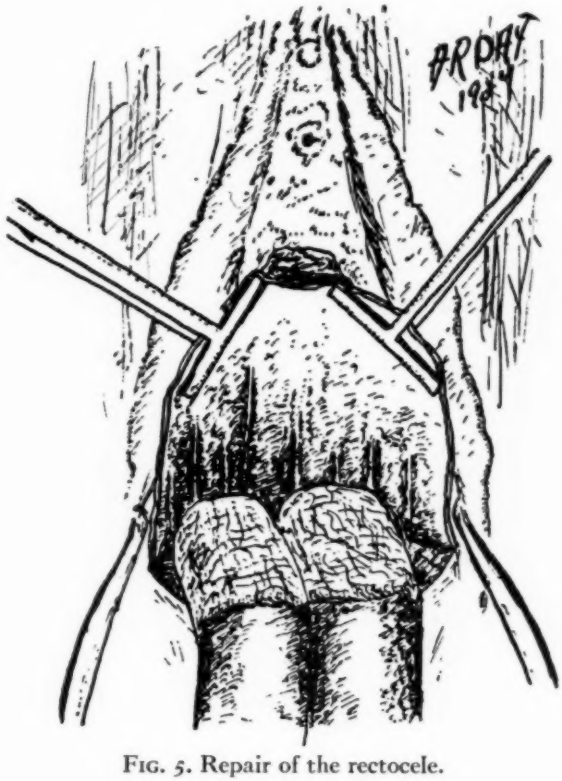

Fig. 5. Repair of the rectocele.

The patient is then prepared as for a gynecological operation. The pubic hair is shaved, the vulva and the pubic regions are thoroughly washed with soap and water, and then irrigated with a mild antiseptic solution. If the patient is in the early stages of labor and the rectum is full, the patient may be given a cleansing enema, but this is not advised shortly before delivery for fear of a spill or contaminations. Small amounts of liquid may be given until within a few hours of the expected time of delivery.

In order to conserve the strength of the patient, some form of analgesia and anesthesia are given when strong pains occur at five minute intervals, and the cervix admits two fingers. We have been using the so-called "twilight sleep," i.e. morphine and scopolamine technique in the early stages, augmented by ether and nitrous-oxide oxygen, with or without ether in the later stages.

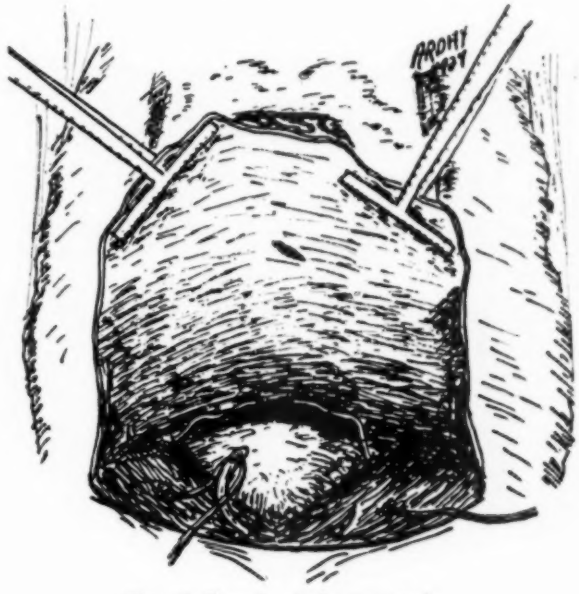

Fig. 6. Repair of the rectocele.

When ready for delivery, the patient is completely anesthetized with nitrous-oxide oxygen or ether or both, depending on the type of delivery, the type of repair and the condition of the patient. She is then placed in the lithotomy position. The vulva, pubis, lower abdomen and upper thighs are thoroughly cleansed with soap and water, washed with sterile water and then sponged with 70 per cent alcohol solution by the nurse. The assistant then goes over the field with a 2 per cent iodine solution, followed by 70 per cent alcohol. The patient is then draped, especial care being taken to keep the anus covered. If the presenting part of the fetus is not too low, the bladder should be emptied by catheterization. To further conserve the strength of

the mother and baby, and also to shorten the length of labor, we do not hesitate to help the dilatation of the perineum by the hand, well lubricated with neutral sterile soap as advocated by Potter. The gloved hand and the vagina are frequently rinsed with 1 per cent lysol solution. Forceps deliveries, versions and pressure on the uterus from above are also done when indicated. (See Table II, Types of Deliveries.)

As soon as the head is delivered, 1 c.c. of pituitrin is injected into the biceps muscle of the patient and may be repeated two or three times if necessary. This causes the uterus to contract, expels the rest of the fetus, and decreases the placental site, thus hastening the third stage of labor and minimizing the loss of blood. After the expulsion of the placenta the mother is given an intramuscular injection of 1 c.c. of ergot. An intern or nurse keeps constant pressure on the fundus during the delivery and repair and for at least an hour afterwards. The patient is then redraped, the gloves are thoroughly washed in 1 per cent lysol or fresh gloves are put on and clean towels are placed in the obstetrician's lap.

EXAMINATION FOR NEW AND OLD LACERATIONS

If the patient's condition is satisfactory, the genitalia are then examined for new and old lacerations. With sufficient experience these can be readily recognized. We can, moreover, forestall the occurrence of subsequent cystoceles and rectoceles by doing primary repairs even where there is no external evidence of lacerations.

The technique of inspection consists of:

(1) The Gelpi-Bubis weighted speculum is inserted.

(2) The anterior and posterior lips of the cervix are grasped with ring-shaped sponge holders, one jaw of each being protected with rubber tubing.

(3) The uterine cavity is wiped with gauze soaked in 2 per cent iodine solution which stimulates the uterus to further contraction, cleans out the blood clots, pieces of placenta or membranes and helps to sterilize the uterine cavity, the cervical canal and vagina.

REPAIR OF THE CERVIX

Nature seldom causes a complete cure and normal restitution of a cervix that has been lacerated. In my experience, I have found that almost all cervices show lacerations even after the so-called normal deliveries. Even a small nick left unrepaired may lead to chronic eversion hypertrophy and infection both local and ascending, and subinvolution, etc. I have emphasized for years[6] that it is safe to examine the cervix after delivery if done according to the rules specified, that no tear is small enough to neglect and that a tear of the cervix is more detrimental to the future health of the mother than a laceration of any other part of the genitalia.

Examination of the Cervix. Immediately after the delivery, the cervix can be readily brought down to the introitus for thorough examination by pressure from above and by pulling on the two sponge or cervix holders. This is also facilitated by the use of an angle retractor placed against the lateral wall of the vagina.

If the cervix is ragged or full of small cysts, a partial amputation may be done with the scissors, knife, cautery or curette. Any bleeding may be controlled by No. 1 chromic catgut sutures, either continuous interlocking or figure of eight.

Any tear more than 1 cm. deep should be sutured. Large tears are repaired as follows: The cervix holders are adjusted to grasp the cervix about 0.5 cm. from the tear and the cervix is pulled over to the opposite side. The angle retractor is then adjusted so as to give the best possible exposure. Old tears are easily recognized after some experience. The old torn surface and scar tissue of the posterior lip are removed by scissors or knife. The same is done to the anterior lip. These two surfaces are then united by interrupted or continuous interlocking sutures with No. 1 or No. 2 chromic catgut, care being taken to remove the

blood on the surface before each stitch, to insert the needle down to the mucous membrane of the cervix and to carry the suture to the very tip, otherwise a nick will remain which may cause future trouble. Any other tears are treated in the same manner. If the technique is carefully carried out, there will be no danger of closing the cervical orifice too tightly and thus interfering with the drainage.

REPAIR OF THE CYSTOCELE

There is some degree of cystocele present in all cases of procidentia and posterior displacements of the uterus. A perfect perineal body does not support the bladder or prevent a cystocele from causing trouble. If it does occur regardless of all precaution at the time of delivery and is recognized, it can be repaired immediately, as is illustrated in one of my cases, which was, I believe, the first of its kind to be recorded.[7]

The following procedure was adopted: a Gelpi-Bubis weighted vaginal speculum was placed in the vagina and the cervix was repaired with interrupted No. 2 chromic catgut sutures. A longitudinal incision was then made along the anterior vaginal wall starting at a point just below the urinary meatus and extending almost down to the cervix. The vaginal mucous membrane and the underlying tissue were incised, exposing the sagging wall of the bladder. The edges of the mucous membrane flaps were grasped with T-shaped forceps and separated from the bladder by blunt dissection as far as the pubic arch.

The pubovesical fasciae near the descending rami of the pubes were then brought together in the median line by several interrupted No. 2 catgut sutures. This gave a new and firm base to the urethra and the bladder. The excess of the vaginal flaps was then trimmed off and the edges were united by a continuous, interlocking No. 1 chromic suture, care being taken to prevent puckering of the anterior wall. The perineum was then repaired in anatomical layers with No. 2 chromic sutures. The patient made an uneventful recovery and examination eight months after delivery showed perfect results. This patient was again delivered four and a half years later. Episiotomy followed by low forceps delivery was done. The anterior vaginal wall was not seen during the whole delivery and two months later examination showed that the patient was in perfect gynecological condition.

VAGINAL FIXATION OF THE UTERUS[8]

We have performed vaginal fixation of the uterus on six women who have suffered from the effects of third degree retroversions following their previous confinements. This can be done after the bladder has been freed from the cervix as in the cystocele operation, but raised higher with a retractor. The uterine muscle is anchored above the internal os to the pubovesical fascia with interrupted No. 2 chromic catgut sutures. Subsequent examinations of the cases showed the uteri in first or second degree retroversion, high in the pelvis and the patients reported great improvement in health.

REPAIR OF THE RECTOCELE

The repair of the perineum, so-called rectocele, depends on:

(a) The extent and direction of the laceration

(b) Whether there is a new laceration superimposed on the old one

(c) The size of the hernial opening

(d) The tone and size of the levator ani and perineal muscles.

The object of the operation is to remove the scar tissue, to cure the hernia, and to replace the various layers of muscles and fasciae in their respective positions. Many types of operations have been developed, but the following technique has given very satisfactory results.

Technique. All instruments, except the Gelpi spreader, are removed and the uterus is pulled back into its normal position by the insertion of the assistant's hand between the pubis and the uterus. Occasionally the uterus is shoved up per vaginam.

A curved incision is then made along the mucocutaneous border between the carunculae myrtiformes. If the line of cleavage is found, it is surprising how readily and with what little bleeding the mucous membrane may be freed from the surrounding tissues. The vaginal edge is grasped by Ochsner forceps (later replaced by a large T clamp), and the posterior wall of the vagina is freed from the muscles until a good exposure of the levator ani muscles is accomplished.

If the hernial orifice is small, it may be closed by a purse-string suture of No. 2 chromic catgut. If the orifice is too large, it is then closed by interrupted figure of eight or x sutures. The levator muscles are then brought together in the mid-line by either continuous or interrupted sutures. The excess and scar tissue of the mucous membrane are removed and the cut edges are brought together with a continuous, interlocking No. 1 chromic catgut suture. After removing the Gelpi retractor, the perineal muscles are coapted with either continuous or interrupted No. 2 sutures, care being taken, however, that no pockets are left and that the vaginal orifice is not closed too tightly. The edges of the skin are then united with continuous or interrupted sutures.

HEMORRHOIDS

A sterile towel or sponge is placed over the perineum and the anus and rectum are examined. If there are any edematous or enlarged hemorrhoids present, the sphincter ani is dilated, the hemorrhoids are either incised and the blood clots expelled or they are removed by knife and sutured with No. 0 chromic catgut. In many cases we have removed clusters of hemorrhoids by a modified Whitehead operation with very fine results.

DELAYED OPERATION

If the gynoplastic operation is done twenty-four or more hours after labor, the following technique is used:

The night before the operation, the patient, if nervous or restless, is given 20 to 30 grains of sodium bromide or 1 grain of luminal. One-half hour before being sent to the operating room, she is given a hypodermic injection of 1 c.c. of pituitrin to decrease the lochia. This is followed fifteen minutes later by a hypodermic injection of morphine sulphate gr. $\frac{1}{4}$ and atropine, gr. $\frac{1}{150}$. Under nitrous-oxide oxygen or spinal anesthesia she is prepared for the operation. The external genitalia and thighs are painted with a 2 per cent iodine solution, followed by 70 per cent alcohol. Great care is taken to wipe the vagina dry without traumatism and to swab it and the cervix thoroughly with a 2 per cent iodine solution, followed by alcohol. The bladder is then catheterized, and the operative procedure is the same as described.

POSTOPERATIVE CARE

As soon as the patient regains consciousness she is returned to her room and kept warm. An infusion of 1000–2000 c.c. of saline solution is given in the thighs or in the axillary space, or 500 c.c. of 5 per cent glucose are given intravenously if indicated for shock, weakness or excessive loss of blood. The patient is made as comfortable as possible, alleviating the pain with generous doses of codeine or morphine. A pillow under the knees and frequent changes of position add to her comfort.

Occasionally these patients are troubled with urinary retention. The various known remedies are employed first and catheterization is used as a last resort, followed by daily instillation of 2 oz. of 1:5000 neutral acriflavine solution or $\frac{1}{2}$ oz. of 5 to 10 per cent argyrol. Urotropin, potassium citrate, or other urinary antiseptics are used when indicated.

The bowel movements are kept soft with $\frac{1}{2}$ to 1 oz. of petrolagar or nujol. The patients are also given daily injections of 4 oz. olive oil after forty-eight hours when a hemorrhoidectomy has been performed. Castor oil, aromatic cascara, etc., are used when indicated.

The mother is given a liquid diet for twenty-four hours, then semi-soft with

plenty of fluids, and a full tray on the third to fifth day. The baby is nursed according to schedule, missing only one or two regular feedings after the delayed operation.

END RESULTS

Table IV gives a résumé of the end results of 151 private cases with findings from three weeks to six years after delivery and repair.

TABLE IV

RÉSUMÉ OF 151 PRIVATE CASES

Time after D. & R.	1st Degree Relaxation (or +)		2nd Degree Relaxation (or ++)		3rd Degree Relaxation (or +++)	
	No. of Cases	Condition after Oper.	No. of Cases	Results	No. of Cases	Results
3 wks.	..	.....	1	1 P.		
1 mo.	3	3 P.	5	4 P. 1 Im.		
5 wks.	2	1 P. 1 Im.	.. 5	3 P. 2 Im.		
6 wks.	..	.....	10	8 P. 2 Im.		
7 wks.	..	.....	1	1 P.		
2 mos.	8	7 P. 1 Im.	.. 6	4 P. 2 Im.	.. 4	1 P. 3 Im.
10 wks.	3	3 P.	3	1 P. 2 Im.		
3 mos.	8	8 P.	4	4 P.	4	4 P.
4 mos.	5	5 P.	3	1 P. 2 Im.	4	4 Im.
5 mos.	5	3 P. 2 Im.	3	3 P.		
6 mos.	2	2 P.	5	4 P. 1 Im.	1	1 P.
8 mos.	..	.....	2	3 P.	3	1 P. 2 Im.
1 yr.	7	3 P. 4 Im.	5	5 P.	1	1 P.
1½ yrs.	2	2 P.	2	2 P.		
2 yrs.	1	1 P.	5	1 P. 4 Im.	1	1 Im.
3 yrs.	2	2 P.	9	7 P. 2 Im.		
4 yrs.	2	2 P.	3	3 P.		
5 yrs.	3	3 P.	4	4 P.		
6 yrs.	..	.....	4	2 P. 2 Im.		
Total....	53	+	80	+	18 = 151 cases	
Summary	Perfect: 113 or 74.7 per cent. Improved: 38 or 24.5 per cent.					

D., Delivery. R., Repair. P., Perfect results. Im., Improved.

COMPLICATIONS

Of a series of 1353 cases, 616 had one or more complications; 737, i.e. 54.8 per cent, had an uncomplicated and uneventful convalescence. Many of these patients were delivered by junior men of limited experience and by resident staff members, which could account for quite a few of the complications.

Two hundred fifty-seven of these cases had so-called postoperative reaction.

Two hundred twenty-one cases or 16.3 per cent (Table v) showed complications that may be attributed to the delivery plus the gynoplastic repair.

TABLE V

COMPLICATIONS ATTRIBUTED TO GYNOPLASTIC REPAIRS

Cystopyelitis, infected perineum	4
Retained lochia	24
Retained lochia, congestion of breasts	8
Phlebitis	14
Sapremia, pyelitis, phlebitis	2
Pleurisy	2
Postoperative hemorrhage	5
Bronchitis	*19
Bronchitis, retention of lochia	2
Bronchitis, cystitis	3
Bronchitis, congestion of breasts	*3
Bronchitis enteritis	*1
Bronchopneumonia	6
Bronchopneumonia, cystitis	2
Septic pneumonia, strept. hemolyt., peritonitis	†2
Sloughing of perineum	2
Sloughing of hemorrhoids	1
Moderate shock	16
Severe shock	5
Anemia during convalescence i.e. below 3,500,000 R.B.C. 60 per cent Hgb	36
Pelvic infection	‡4
Mild infection	14
Paralytic ileus	1
Resuture	2
Edema of perineum	5
Ischiorectal abscess	1
Perforation of rectum	2
Perforation of bladder	1
Metritis and parametritis	3
Pulmonary embolism	‡2
Catheterized 3 or more days	27
Total	221

* Cause of complication uncertain.
† Two died.
‡ One died.

Five deaths (Table VI) occurred in a series of over 1700 cases to date (Jan. 1, 1932). The mortality percentage is less

TABLE VI

DEATHS

Name	Age	Para	Date of Admiss.	Type of Deliv.	Date of Operat.	Type of Operat.	Date of Death	Cause
M. S.	32	iii	7/25/23	Spontaneous	7/25	P.	8/3	8/1. Blood culture positive for Hemolyt. Strept. Fever began 7/27/23.
K. W.	42	vi	4/16/26	Transverse presentation V. & E. after 40 hrs. of labor.	4/21	T.C.P.	5/29	5/11. Vaginal I & D for pelvic infection Septicemia, septic bronchopneumonia 5/27/26. Blood culture positive for Hemolyt. Strept.
B. H.	39	v	7/ 1/27	Premature separation of placenta. Man. dil. cer., M.F. Pulse during delivery: 148. Cyanosis and vomiting.	7/6	T.P.	7/13	Pulmonary embolism 12 days post partum.
A. G.	40	iv	10/26/27	R.O.P. Sc., L.F.	11/2	T.C.P.	11/6	10/31. Slight cold. 11/2/27. Considerable bleeding during operation. 11/6/27. Pulmonary embolism.
F. B.	29	iii	3/14/28	L.F.	3/14	T.P.	3/30	Peritonitis, Strept. Hemolyt. Septic pneumonia.

Compare this with the report by C. W. Frank of New York[9] (Table VII).

than 0.3 per cent, which is lower than the United States maternal mortality record.

TABLE VII

MATERNAL DEATHS[9]

	Year	Number of Cases	Number of Deaths	Per Cent Rate	Per Thousand
New York City	1929	124,404	629	0.50	5.0
Nursery and Child's Hospital	1929	2,180	6	0.27	2.7
Woman's Hospital	1928–9	2,713	26	0.95	9.5
Lying-In Hospital	1929	4,653	21	0.45	4.5
Bronx Hospital	1927–8–9	2,268	6	0.27	2.7

ECONOMICAL PHASE

Many women find it financially impossible to leave their families and enter the hospital for gynoplastic repairs. They generally postpone doing so until their minor complaints have developed to such proportions as to demand a major operation. The expense, the help problem and the fear of the operation are all factors which hinder her from taking any definite steps. By doing the necessary gynecological repairs at the time of confinement, it has been possible to put these patients in much better physical condition and at the same time not prolong their convalescence to any great extent. It is our routine to keep the obstetrical or gynecological patients in the hospital from twelve to sixteen days, while the average stay for delivery and repair was 15.3 days, and 14.6 days after operation for delayed cases.

CONCLUSIONS

1. Very few women go through one or more childbirths without resultant lacera-

tions, scars and relaxations. Repairs, as indicated in this thesis, are done to prevent mild cases from becoming incurably chronic and to give the more severe cases relief and renewed health.

2. Contrary to previous teachings, the tissues and the extent of damage can be easily recognized, the lochia does not interfere with the healing of the tissues and the dangers of infection are very small if the strictest asepsis and antisepsis prevail.

3. It is safe and advisable to examine and repair the cervix after the delivery with the proper precautions. A torn cervix is more detrimental to the future health of the mother than a relaxed perineum.

4. Operative deliveries are not contraindications to repairs if surgical judgment and technique are used as outlined in the text.

5. Practically all types of gynoplastic repairs may be done after deliveries.

6. Subsequent deliveries are not often complicated by the previous repair work. These patients are treated as primiparae and any new tears are repaired immediately.[8]

7. There were 5 deaths in a series of over 1700 cases or a mortality of less than 0.3 of 1 per cent. This is lower than the accepted maternal mortality of the United States.

8. The maternal morbidity also compares favorably with other clinics where *no* gynoplastic repairs for old lacerations are done.[10]

9. In a combined series of private and ward cases (248) 74.4 per cent had perfect results and 24.6 per cent were markedly improved.

10. This procedure is a great financial saving to the patient and the community.[11,12]

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[For Remainder of References see p. 220.]

* Continued from page 182.

INTESTINAL OBSTRUCTION

APPLICATION OF SOME OF THE NEWER PRINCIPLES EVOLVED FROM EXPERIMENTAL AND CLINICAL EXPERIENCE*

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THERE is no surgical catastrophe of the human body that is as complex and that requires as much judgment in the way of treatment as does acute intestinal obstruction. Experimental workers have failed to identify a "specific toxin of obstruction," but we owe these workers much valuable information relative to the factors which produce symptoms, as well as knowledge gained about profound chemical changes that may occur in the course of an acute ileus.

SIMPLE MECHANICAL OBSTRUCTION OF SMALL BOWEL

In high obstructions the initial symptoms are not due to absorption of toxins but to loss of digestive juices from vomiting and the failure to reabsorb the digestive juices which are normally reabsorbed in the lower small bowel and ascending colon. As the main function of the upper portion of the small bowel is to secrete and that of the lower small bowel to absorb, one can readily understand why the loss of digestive juices in high obstructions produces earlier and more acute symptoms than obstructions of the lower ileum. Furthermore the great secretory activity of the upper small intestine produces an earlier and more marked increase in intraintestinal pressure; this, coupled with the comparatively longer intramural veins in the upper gut, results in an earlier vascular embarrassment in the involved loops. This early increase in intraintestinal pressure which occurs in high obstructions is somewhat counteracted by the beneficent decompressing effect of the stomach, which is able to distend considerably and empty itself by vomiting.

If a mechanical obstruction is not soon relieved, the venous and capillary stasis which result cause the escape of considerable plasma into the lumen and wall of the intestine and into the peritoneal cavity. This loss of blood constituents produces a condition similar to traumatic shock, namely a fall in blood pressure associated with a diminution in the venous blood volume return. The fall in blood pressure occurs first in the diastolic phase, followed soon by a fall in the systolic phase. Many symptoms which were formerly ascribed as being due to a "toxemia" are undoubtedly due to this "shock-syndrome" effect.

In simple mechanical obstruction of the small bowel, whether high or low, absorption of toxins is of little importance until the vascular embarrassment in the obstructed bowel from increasing intraintestinal pressure has become pronounced enough to produce necrotic changes in the mucosa due to lack of circulating blood.

That the loss of digestive juices is the important factor in the production of the first symptoms of simple obstruction of the small bowel and that the vascular disturbances in the gut that result from increasing intraintestinal pressure are the cause of the "shock" symptoms and still later of toxemia is proved by many experimental and clinical facts. Particularly striking is the following experiment of White and Fender:

A dog with a complete high obstruction, decompressing himself by vomiting, can be

* Submitted for publication February 15, 1932.

kept alive for a month provided that the loss of his digestive juices is compensated by reinjecting the vomitus into the bowel below the obstruction.

Loss of Cl and H_2O of the gastric secretion from vomiting and failure to be reabsorbed lower down because of the obstruction produce dehydration, hypochloremia and an increased alkali reserve (alkalosis). A high N. P. N. of the blood (especially of urea) occurs which is the result of dehydration.

Loss of pancreatic juice can occur in high obstructions either by back-flow into the stomach or by failure to be reabsorbed below the obstruction. It is also lost when decompression jejunostomies are performed. Loss of this juice causes death in a comparatively short time. The anion Cl and the cations Na, K and Ca and possibly certain hormone-like substances are lost.

The excess of fixed bases over Cl in the pancreatic juice results in a decrease of the alkali reserve (acidosis) when this secretion is lost. One must not lose sight of the fact that loss of chlorides from vomiting, tending to produce as it does an alkalosis, is sometimes counteracted by the loss of fixed bases contained in the pancreatic juice, with a resulting tendency to acidosis. Thus the CO_2 combining-power of the plasma may not show much alteration despite a profound loss of electrolytes and bases.

The pancreas secretes a hormone-like substance which is reabsorbed in the intestine and which seems to influence metabolic functions in the liver, particularly that of fat metabolism. Loss of this hormone-like substance results in cloudy swelling and fatty infiltration of the liver and later a necrosis of liver cells and atrophy of liver cords (Berg and Tucker).

A dog with a jejunal fistula, receiving normal NaCl to replace electrolytes lost, does not live as long as a dog with a jejunal fistula whose pancreatic juices are reintroduced into the jejunum, which proves that something besides loss of H_2O and electrolytes kills these animals. Berg and Tucker suggest that the loss of the "hormone" that influences fat metabolism in the liver is an important factor.

OBSTRUCTION OF LARGE BOWEL

The large bowel with its ability to absorb water and its ability to expand under pressure rarely produces acute symptoms from an obstruction, with the exception of volvulus. As most obstructions of the large bowel are due to carcinoma, the diagnosis should not be hard to make and the method of surgical approach is well-defined.

STRANGULATION OBSTRUCTION

The clinical course is so rapid that hypochloremia, dehydration etc., do not have time to develop materially. As a result of the shock and toxemia the entire circulation is affected early. Tremendous splanchnic engorgement results, with a deficit in the peripheral circulation.

Hemorrhage occurs into the strangulated loop as well as the gut above and a bloody fluid collects in the peritoneal cavity. This loss of blood plays an important role in either initiating or aggravating the condition of shock.

A high blood N. P. N. occurs, probably from the action of toxins on body proteins directly, as well as from the profound circulatory changes and depression of kidney function. The adrenals apparently become depleted early.

ADYNAMIC (PARALYTIC) ILEUS

According to Alvarez this is not a paralytic ileus in the sense that the intestinal muscle has lost its ability to contract. He has been able to show that strips of muscle removed from the bowel wall of a case of paralytic ileus still possess the functions of contractility, rhythmicity and irritability.

According to Hotz it is the distention of gas which produces the injury to the intestinal muscle; at the same time the distention compresses the veins in the intestinal wall which normally carry off considerable

amounts of gas by diffusion, further aggravating the distention.

Adynamic ileus can be divided into three clinical groups:

(1) *Simple:* This is usually due to excessive splanchnic stimulation and irritation from undue manipulation of viscera and the post-cathartic inhibitions which are intensified by ether anesthesia. The excessive inhibition that results produces a condition of "paralysis" of the intestinal tube, or as Alvarez would say, a flattening or reversal of the normal intestinal gradient.

(2) *Peritonitic:* This is the most common form of adynamic ileus and is the result of localized or general peritonitis. Many surgeons are of the opinion that it is the ileus that causes death in peritonitis. Of course this is a disputed point, but no one of experience will deny the frequently excellent results that follow an early high enterostomy performed upon a case of paralytic ileus complicating a peritonitis that is spreading but has not become generalized.

The experiments of Arai indicate that the paralytic ileus of peritonitis is due to excessive inhibition resulting from irritation and stimulation of the splanchnics rather than to a paralysis of the intestinal muscle. He cut the splanchnics in normal animals and noted the increased peristalsis. He then produced peritonitis and found that it had no effect on the peristalsis and came to the conclusion that all slowing in peristaltic movements in peritonitis is due to excessive splanchnic inhibition.

Perhaps the observations of Handley, Alvarez, Arai and others may revolutionize our treatment of peritonitis. The treatment of today includes the use of morphine in large doses to produce rest of the bowel. According to Alvarez large doses of morphine frequently produce reversed peristalsis, or in other words exaggerate the "flat gradient" existing in the paralytic ileus of peritonitis. According to Dragstedt morphine produces an increase in intestinal tone and increased frequency of contractions, and the "interpretation of its beneficial action (in peritonitis) must be on some other basis than that of abolishing intestinal activity and putting the intestine at rest."

Early decompression by means of a jejunostomy, combined with paravertebral or intradural injections of novocaine to block the splanchnics, and especially the use of hypertonic saline solution intravenously to increase intestinal tone and propulsive motility may supplant the present-day physiologic-rest method of treating peritonitis. Is the surgeon who advocates the physiologic-rest treatment producing rest to the bowel by giving large doses of morphine?

As most cases of peritonitis start in the pelvis and most commonly from a gangrenous appendix, it is essential that a jejunostomy be performed before the peritonitis has become generalized. No attempt should be made to approach the area of peritonitis, for fear of opening the "flood-gate" that would hasten the production of a general peritonitis.

(3) *The post-obstructive* variety of adynamic ileus is probably a true paralytic ileus. The segment of bowel above an obstruction, injured by the tremendously increased intraintestinal pressure, is loath to regain its tone and motility after the obstruction has been released.

POSTOPERATIVE ILEUS

(1) Sudden unexplained vomiting occurring about forty-eight hours after an operation for acute appendicitis should immediately arouse the suspicion that a loop of gut has become "paralyzed" as the result of a localized peritonitis. Delay in performing an enterostomy in this type of case while waiting for an "abscess to turn up" is responsible to a certain degree for the mortality that still exists in the surgical treatment of acute appendicitis. A high Witzel enterostomy should be performed, but the field of the previous operation is to be carefully avoided. Any intraperitoneal abscess that

may result should not be opened until "coffer-damming" has occurred.

(2) Sometimes during the convalescence from an abdominal operation trifling adhesions of a mild healed peritonitis produce a matting of loops of bowel and multiple obstructions may result.

METHODS OF ABSORPTION OF TOXINS FROM OBSTRUCTED BOWEL

Absorption occurs (a) through the blood stream, and (b) transperitoneally, i.e. through the bowel wall into the peritoneal lymph spaces.

(1) *Blood Stream Absorption.* Some absorption of abnormal products probably occurs directly through the splanchnic circulation, but the main and frequently lethal absorption of toxins does not occur until the local circulatory changes have become so pronounced that the route of absorption must be through the bowel wall and thence into the peritoneal lymph channels.

(2) *Transperitoneal Absorption.* Increasing peristalsis and the accumulation of digestive juices and gases produces a gradually increasing intraintestinal pressure, with the result that venous stasis is followed by capillary stasis, and finally complete ischemia of the part results. It is in this latter stage that active absorption of toxic material commences.

IMPORTANCE OF TRANSPERITONEAL ABSORPTION

There are experimental and clinical facts to emphasize this:

(a) A gangrenous loop has no circulating blood, yet toxemia is most pronounced in this type of case.

(b) McIver and White found that cats with experimental volvulus of the small intestine died in about twenty hours. The only method that prolonged life, besides resection of the strangulated gut, was removal of the strangulated loop to the outside of the abdomen. Two animals treated in this way lived three and five days.

(c) Costain found that dogs with intestinal obstruction and fistula of the thoracic duct lived much longer and recovered more promptly after release of the obstruction, than control dogs without such a fistula. (Normally many of the lymphatics of the peritoneum drain into the lymph channels of the diaphragm. It is likely that under the altered conditions existing in an obstructed gut, toxins enter the thoracic duct in an abnormal manner.)

(d) Murphy and Brooks produced a thoracic-duct fistula, then made a closed loop and injected material from the intestinal contents of a dog dead of obstruction. They next increased the pressure in the loop. The thoracic-duct fluid soon became blood-tinged. This material when injected into other animals caused toxemia and death.

(e) Stone and Firor demonstrated the toxicity of Ringer's solution in which had been suspended an inflated closed loop of intestine. (Wangensteen could not prove any toxicity in the bloody peritoneal fluid of a case of strangulation.)

(f) Strangulated inguinal or femoral hernia is not nearly as rapidly fatal as a strangulated internal hernia.

(g) Gatch's experiment: He was not able to find any sign of absorption of nicotine until the pressure in the closed loop reached about one-half the systolic blood pressure. With the loop outside of the abdomen there was no absorption when the intraintestinal pressure equalled the systolic blood pressure. If the loop, distended to the systolic blood pressure level, was again introduced into the peritoneal cavity an immediate absorption of nicotine occurred.

FOUR FACTORS THAT ENTER INTO PRODUCTION OF SYMPTOMS

Many symptoms that were formerly ascribed as being due to the absorption of

"toxins" have recently been shown to be due to other causes, such as:

(1) Disturbances of chemical equilibrium from loss of H_2O, Cl, fixed bases, etc., due to vomiting and failure of reabsorption beyond the obstruction.

(2) "Shock-syndrome" effects, due to splanchnic engorgement and stasis, dehydration and most particularly from local loss of blood plasma into the gut, gut wall and peritoneal cavity.

(3) Some nervous factor, according to Meek and Ivy and Kelley, enters into the production of symptoms. These workers showed that depression, anorexia and vomiting which occurred in dogs as the result of distention of a loop of gut could not be reproduced in another series of dogs when the loops had been previously denervated.

(4) Finally we come to toxemia, which is a rather late manifestation in all forms of obstruction excepting the strangulated types.

RELATION OF ADRENALS TO TOXEMIA OF INTESTINAL OBSTRUCTION

Even though it is purely hypothetical this relationship is worth considering.

Animals whose adrenals have been removed are more sensitive to the injection of various toxic substances than normal animals. It is probably the loss of cortex hormone that is responsible for this increased sensitivity to toxins.

Animals dead from intestinal obstruction show more or less characteristic changes in the adrenal glands (Cutting).

Is the excessive destruction of amino-acids which occurs in profound toxemia of obstruction responsible for the lack of certain amino-acids such as tryptophane and tyrosine, which are essential to the manufacture of the internal secretion of the adrenals?

The protective function of the adrenal cortex against injection of toxins suggests the use of cortin in the treatment of the toxemia of intestinal obstruction.

SUPPORTIVE TREATMENT

On the basis of experimental and laboratory findings the following supportive treatment is indicated:

Normally 7500 c.c. to 10,000 c.c. of digestive juices are secreted in twenty-four hours to be absorbed again in the lower smaller intestine. When one remembers that 70 per cent of the body tissues is composed of H_2O and that a loss of 10 per cent of this amount of H_2O proves fatal and when one realizes further that the ability of the body to hold H_2O depends upon the dissolved electrolytes, particularly NaCl, it becomes quite apparent that an obstruction of the small bowel can produce pronounced chemical changes in the body.

(1) *Indications for Use of Intravenous Normal Saline Solution.* The rapid dehydration and chloride depletion resulting from vomiting and failure of reabsorption of digestive juices are best treated by means of normal saline solution. When loss of chlorides is excessive, higher percentages of saline should be administered.

A high N. P. N. of the blood can occur as the result of dehydration. A marked fall in the N. P. N. occurs following the administration of normal saline showing that this excessive accumulation must be due to loss of chlorides, because it is uninfluenced by the administration of plain H_2O or dextrose solution.

It must be borne in mind that the increased supply of H_2O that follows the use of normal saline solution increases intestinal secretion as well as intestinal motility, both augmenting intraintestinal pressure. For this reason decompression of the blocked bowel should be done concurrently or soon after the administration of the normal saline solution intravenously.

(2) *Indications for Intravenous Dextrose Solutions.* In the preceding paragraph we mentioned that a marked fall in the high N. P. N. of the blood occurs when normal saline solution is given to combat the dehydration of vomiting and failure of reabsorption. One must not lose sight of

the fact that excessive destruction of body proteins with a resulting high N. P. N. can also occur as the result of the action of toxins (?) and from the profound disturbances of the peripheral and splanchnic circulation that occur in the shock-syndrome ileus. In these cases dextrose is superior to saline because it acts as a "protein-saver." Dextrose solutions possess definite diuretic properties which are also of benefit. There is also experimental evidence that indicates that a liver well loaded with glycogen is less susceptible to the effects of toxic agents.

The longer a case of obstruction has gone the greater the value of dextrose. In delayed cases it must be given at the rate of 75 gm. every two hours in order to supply enough calories to maintain basal heat production.

Whenever dextrose is administered in cases of ileus it should be given in normal saline, because dextrose definitely inhibits and NaCl stimulates intestinal motility.

(3) *Indications for Intravenous Ringer's and Hartman's Solutions.* When the loss of pancreatic juice is excessive as from high obstructions and from decompression jejunostomies, the use of Ringer's solution or better still Hartman's solution is indicated. The latter consists of NaCl, KCl, $CaCl_2$ and sodium lactate in proper proportions and thus contains the electrolytes and fixed bases lost from the pancreatic secretion and the sodium lactate is effective in combating any tendency to acidosis.

(4) *Indications for Intravenous Hypertonic Saline Solutions.* There are three distinct indications for the use of hypertonic saline solutions in the treatment of ileus: (a) The chloride loss is supplanted. (b) It increases markedly the intestinal tone and propulsive motility. The uncertain results that have followed the use of various drugs in the treatment of paralytic ileus is probably due to the fact that they increase the tone and nonpropulsive contractions of the intestine. P. E. Reid and A. C. Ivy have shown that morphine and pilocarpine produce this effect, and they have been able to prove that hypertonic saline solution increases the propulsive type of motility in a jejunal loop when the loop is manifesting subnormal propulsive motility. (c) Hypertonic saline solution has a pronounced effect on metabolism, especially when administered in larger amounts. Elevation of heat production follows its use and this is explained as being due to the fact that when the hypertonic saline solution enters the circulation H_2O is withdrawn from the tissues to render the solution isotonic. This withdrawal of H_2O from the tissues carries with it stored food materials which are converted into energy in the form of increased heat production.

In the toxemia and shock of ileus there is a diminution of venous blood return to the heart due (a) to escape of plasma from the blood into the tissues because of increased permeability of the capillaries and (b) to capillary stagnation. The reversal of the flow of fluid through the capillaries that follows hypertonic saline injections is advantageous. An intravenous injection of 100 c.c. of 15 per cent NaCl is capable of increasing the blood volume by 500 to 1000 c.c. The increased heat production should likewise be of benefit because the temperature in the early stages of ileus is often subnormal. The effect of hypertonic saline solution of reversing the flow of fluids, as well as its effect upon heat production, probably explains the apparent benefit that sometimes follows the use of saline in certain cases of acute ileus where dehydration and hypochloremia had not had time to develop. Because it increases intraintestinal pressure, hypertonic saline solution should never be used until after decompression of the gut has been started by the removal of the obstruction or by the performance of an enterostomy. Exceptions are certain cases of paralytic ileus that are not due to peritonitis where the use of 15 c.c. to 50 c.c. of 20 per cent NaCl usually suffices when accompanied by decompression of the stomach and duodenum by means of duodenal intubation.

In the paralytic ileus of a localized peritonitis the use of hypertonic saline solution should be accompanied by the performance of an enterostomy.

Because of their tendency to withdraw H_2O from the tissues, hypertonic saline injections should be followed by the use of large amounts of H_2O.

Because hypertonic saline has no effect upon the anal sphincters it is advisable to resort to the use of a rectal tube when administering this form of treatment.

(5) *Indications for Blood Transfusions.* In the acute cases of obstruction, especially of strangulation, the improper filling of the heart which results from the diminished venous-blood volume return is best met by giving blood transfusions. (Hypertonic solutions of dextrose in saline can be used too, although they are less effective than blood. A hypertonic solution of dextrose with its large molecule of sugar is apt to remain longer in the "leaky" capillaries than an isotonic solution, say of NaCl, with its smaller molecule.)

SURGICAL TREATMENT

In every form of mechanical obstruction there occurs formation of toxic material, but the rapidity of absorption is influenced by the amount of intraintestinal pressure. An experimental animal can live for weeks with a thousand times the lethal dose of toxin in an obstructed loop provided that the pressure in this loop is kept below the level where transperitoneal absorption occurs. Hence, with the exception of high obstructions where death can ensue from loss of H_2O and electrolytes, it is our duty to overcome as early as possible the conditions which favor the increase in intraintestinal pressure.

(1) *Removal of Obstruction.* In early cases this is all that is necessary to accomplish the desired result. If much manipulation be required to remove such an obstruction, it is advisable to refrain from doing anything more than an enterostomy. Laewen has shown in animals with experimental ileus of twenty-four hours' standing that stroking and "milking" of the gut above an obstruction resulted in a marked fall in blood pressure.

(2) *Relief of Gas Pressure.* Since normally large amounts of gases in the intestine are reabsorbed into the blood stream by the process of diffusion and since putrefaction results from stagnation of intestinal contents, it is readily understood that disturbance of the splanchnic circulation as well as the block in the intestine must result in the accumulation of considerable gas, with the resulting distention and relaxation of the intestinal musculature. Since gas is not easily propelled, especially when intestinal contractions are disordered, it is seen how imperative it is to eliminate these gases. Frequently the gases accumulate nearest the obstruction, whereas the liquid contents accumulate a little higher up. It is the accumulation of gas, rather than fluid, which so profoundly affects the blood flow through the bowel wall. When the gas pressure equals the systolic blood pressure, complete ischemia of the part occurs and gangrene may result, first manifesting itself in the villi at the antimesenteric border. Often, as a result of distention, kinking and lengthening of the intestinal tube, multiple "gas-traps" are formed. An original simple obstruction is thus converted into a case of multiple obstructions. These "traps" are best handled by puncturing them with the finest hypodermic needle. Great care must be exercised in avoiding leakage of fluid by introducing the needle only through the thickness of the thinned-out gut wall and by withdrawing it quickly after the gas has escaped. One mattress stitch of the finest silk should be introduced before the puncture is made and tied as the needle is withdrawn. A fresh needle should be used for each puncture. When all of these precautions are observed intestinal fluid cannot escape and the dangers of producing a peritonitis are avoided.

(3) *Exteriorization.* Exteriorization with immediate application of clamps above

and below the seriously damaged gut of strangulation or advanced simple mechanical obstruction is imperative.

We would like to emphasize that in many cases of simple mechanical obstruction the intestine immediately proximal to the point of obstruction becomes seriously damaged as the result of the circulatory stasis from increased intraintestinal pressure. It is these cases that are often a great problem to the surgeon because of the doubtful viability of the segment of gut. *When in doubt it is advisable to exteriorize* and thus avoid the dangers of peritonitis resulting from perforation of a gangrenous area.

No attempt should ever be made to do a resection and immediate anastomosis in any case of seriously damaged gut of strangulation or simple obstruction.

The exteriorized gangrenous gut is removed by a cautery, but the clamps are to remain on both limbs of the loop for at least twelve hours, until the adhesions have formed between the gut and peritoneum, thus preventing leakage of highly infective contents into the peritoneal cavity. The distended gut above the obstruction is next decompressed by means of a high enterostomy. The tube, which should be of soft rubber, can often be introduced a considerable distance without manipulation of the intestine. In twelve hours the clamp is removed from the two limbs of the loop that had been exteriorized and cauterized and the proximal limb is connected with the distal limb by means of a short curved glass tube. The tube leading into the high enterostomy can be withdrawn for a considerable distance after decompression has been obtained and feeding commenced as in jejunal alimentation. The digestive juices are thus being saved and the intestinal flow has been temporarily re-established. At a convenient time the last two stages of a three-stage Mikulicz operation can be performed upon the two segments that represent the limbs of the exteriorized loop.

(4) *High Enterostomy.* We would like to stress the importance of doing a high enterostomy through comparatively healthy gut. Alvarez says: "It is well-known that in acute ileus the bowel for some distance above the obstructed and highly irritated segment is empty; food residues are held back in the duodenum and jejunum and *if an enterostomy is to do any good the opening must be made far orad in the region of the gut where material has accumulated.*" The greatest drawback to a high jejunostomy has been the loss of pancreatic juices. The loss of electrolytes and fixed bases contained in this secretion can be controlled by the use of saline, Ringer's and Hartman's solutions. The loss of the "hormone" contained in the pancreatic juice that probably affects the fat metabolism in the liver is not serious unless the secretion is permitted to escape for a number of days. *In order to avoid the loss of pancreatic secretions the surgeon should make the necessary provisions so that alimentation can be started through the enterostomy as soon as it has completed its function of decompression.*

We have already described measures to insure alimentation in cases where exteriorization of gangrenous gut is done.

In cases of simple mechanical obstruction of the upper bowel that require decompression but do not need exteriorization we advise doing also an enterostomy of the collapsed bowel below the obstruction in order to permit of alimentation. A loop of the collapsed gut is sewed into the lower end of the laparotomy wound and in twenty-four hours it is opened by means of a trocar and a small catheter is introduced through the cannula. The contents above the obstruction can then be transported through the decompression enterostomy to the enterostomy beyond the obstruction by means of a catheter and syringe or the feeding pump.[1] Alimentation can be continued until such a time as

[1] This pump is described in my article: Treatment of certain cases of duodenal ulcer by jejunostomy. Am. J. Surg., 15: 105, January, 1932.

further reconstructive surgery of the bowel may be necessary.

ADVANTAGES OF HIGH ENTEROSTOMY

An enterostomy performed in comparatively healthy bowel well above the obstruction possesses these advantages over an enterostomy in a markedly distended loop:

(1) *Slower decompression* occurs with the performance of a high enterostomy. A sudden release of large amounts of fluid and gas sometimes results in a severe aggravation of symptoms.

(2) *There is less liability of leakage* when a Witzel enterostomy is done in comparatively healthy bowel. Rubber-covered clamps can be used and the contents of the segment aspirated before introducing the tube.

(3) *The contents are less infective.*

(4) *Manipulation of distended, diseased bowel is avoided.*

(5) *More efficient decompression is obtained* when the tube is inserted higher and permitted to extend caudad for a considerable distance, than when it is introduced into a paralyzed, distended loop. Decompression is further enhanced by using the suction feature of the electric pump.

CHOICE OF ANESTHETIC

(1) *General anesthetics* such as ethylene, nitrous oxide and ether are contraindicated in the surgical treatment of intestinal obstruction. The two former, ethylene and nitrous oxide, do not give the necessary relaxation to permit of any kind of surgical intervention in an abdomen usually tremendously distended. The "mauling" of the intestine that is bound to result augments the toxemia.

Ether, even though it affords considerable relaxation, is contraindicated for the following reasons: (a) Danger of aspiration pneumonia unless continuous gastric drainage is used. (b) There is a diminished vital capacity of the lungs in ileus cases due to bowel distention and as a result pulmonary complications are more likely to result when ether is used. (c) Ether is dangerous in shock. Animals anesthetized with ether withstand only $\frac{1}{10}$ the lethal dose of histamine. (d) Ether lowers or reverses the intestinal gradient very markedly. (e) Many patients while being etherized are likely to swallow considerable amounts of air which is certainly undesirable in cases of intestinal obstruction. While recovering from the effects of ether there is often considerable retching and vomiting, both of which are associated with swallowing of air.

(2) *Spinal anesthesia* has many advantages over ether. Its greatest advantage lies in the relaxation it affords, as well as the contracted state of that portion of the bowel whose circulation has not been seriously interfered with. As a result less difficulty is encountered in examining the abdomen and less manipulation of the bowel is required. In contradistinction to ether which lowers or reverses the intestinal gradient, spinal anesthesia because it paralyzes the splanchnics enhances the intestinal gradient, which is desirable in treating most cases of ileus. The greatest disadvantage of spinal anesthesia is the tendency for the blood pressure to fall, which likewise is a condition that prevails in many cases of obstruction.

As long as the blood pressure is not immoderately low when the spinal anesthesia is started, the fall in pressure can be met by the preliminary intramuscular injection of ephedrine, intravenous injections of 10 per cent dextrose in normal saline, CO_2 inhalations and by keeping the patient in the Trendelenburg position.

(3) *Abdominal Block Anesthesia.* If the blood pressure is unusually low as a result of severe intoxication, spinal anesthesia is definitely contraindicated. The condition of this type of patient certainly would not permit of any surgical intervention other than decompression by enterostomy, which can be performed under local anesthesia.

SUMMARY

1. In simple mechanical obstruction of the small bowel, particularly of the duodenum and jejunum, the earliest symptoms are due to dehydration and other chemical changes in the blood and tissues from loss of electrolytes and fixed bases due to vomiting and failure of reabsorption of digestive juices in the lower bowel.

Shock-syndrome effects and some nervous factor connected with distention of the gut are important in the production of symptoms of intestinal obstruction.

Toxemia ordinarily does not play a rôle in these cases until the intraintestinal pressure has increased to the extent of seriously impairing the circulation in the involved segment of bowel, thus producing gangrenous changes in the mucosa.

2. Paralytic ileus is most frequently due to peritonitis. The inhibition of function of the gut is due to excessive splanchnic irritation. As a result of the inhibition, the intestine distends from the accumulation of gas and liquids. Re-establishing the normal gradient by blocking the splanchnic stimulation, using hypertonic saline solution freely to stimulate peristalsis, and decompressing the distended intestine by a high enterostomy, are recommended.

3. In strangulation obstruction, the profound local circulatory changes result in an early and serious toxemia and shock. Whether the toxemia is due to an enterotoxin or to liberation of toxic substances from gangrenous patches in the gut, has not been settled.

It is a clinical fact that the intestine immediately proximal to a simple mechanical obstruction, as well as the markedly distended loops in paralytic ileus, often shows serious damage to the gut wall as the result of the tremendous increase in intraintestinal pressure. Treatment then becomes the same as for strangulation obstruction, namely exteriorization when possible and decompression by enterostomy.

4. The possibility of gas-traps resulting from a primary, simple obstruction because of lengthening and twisting of the intestinal tube must be borne in mind and surgical treatment is to be directed toward overcoming these multiple obstructions.

5. The advantages of a high enterostomy with the introduction of a soft tube for a considerable distance and the production of slow decompression by means of suction from an electric pump are stressed.

6. Conservation of pancreatic juice, particularly when jejunostomies are performed, is desirable, and methods of accomplishing this are described.

7. Blood transfusions, hypertonic and normal saline, and dextrose solutions are definitely indicated in the treatment of various forms of ileus.

The effect of hypertonic saline solution on peristalsis and the effect of the large amounts of water contained in normal saline and dextrose solutions upon intestinal secretion are to be borne in mind. They increase intraintestinal pressure and for that reason decompression should accompany the introduction of these solutions whenever conditions permit.

8. The unsatisfactory results that have followed the use of various drugs to stimulate peristalsis are probably due to the fact that they stimulate certain forms of intestinal contractions, but they do not increase propulsive movements. That hypertonic saline solution does increase these latter movements has been shown both experimentally and clinically.

9. The many disadvantages of ether and the advantages of spinal anesthesia are discussed.

10. The fall in blood pressure which occurs with spinal anesthesia, and which can usually be prevented, is due to a dilatation of the smaller vessels of the skin, muscles and splanchnic areas and is not due to a diminution in circulating blood volume as occurs in shock.

A SIMPLIFIED TYPE OF ROENTGEN PELVIMETER*

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MATHEMATICAL CALCULATIONS
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ROENTGEN pelvimetry is no longer a new subject and the object of this writing is not to enter into any detailed account of the technique of this procedure or to discuss the gradual growing use or value of this modern method of taking pelvic measurements. Suffice it to say, that those who have been accustomed to its use well know its superior value over any of the older methods. They also recognize its simplicity as well as its valuable accuracy.

In England and in America considerable work has been done with roentgen pelvimetry in the past two years. In our own country, in my opinion, the best work along these lines has been done by Dr. Herbert Thoms of New Haven, and Dr. Julius Jarcho of New York City.

Dr. Herbert Thoms has written several articles dealing in some manner or other with the subject over the past several years, some dating as far back as 1922. The last article of his, with which I am acquainted, appeared in May, 1929.[1] In this article he discusses the subject in a very concise and explanatory manner, describing in detail the type of roentgen pelvimeter he uses and also the technique of the procedure.

Dr. Julius Jarcho's latest article on the subject appeared in November, 1931.[2] He goes into the subject with considerable detail and brings out what I consider an important fact in the technique of taking the roentgenograms. His procedure is to have the plane of the superior strait of the pelvis parallel to the film and it is especially in this type of a procedure that the pelvimeter I am about to describe is best adapted. In his procedure he also uses a Bucky diaphragm which, in my opinion, should be used to get the required detail when the patient is placed in the semi-upright position, giving the pelvic strait the parallel position as before mentioned.

To any one interested in the subject these two articles will give a very concise and detailed account of the method of doing roentgen pelvimetry.

Thus far, the roentgen pelvimeter described by recent authors has consisted of a lead plate mounted on some sort of a board which in turn was mounted on uprights or legs. The latter can be raised or lowered to any desired position which would bring the lead plate to the same level as the region which was to be measured. The lead plates used and described have been of various thicknesses. Some are permanently mounted and some merely placed on top of the board as described above. However, they all consist essentially of a moderately thin lead plate large enough to cover a 14 × 17 inch *x*-ray film. These plates are entirely covered with small perforations 1 cm. apart and arranged in rows at right angles to each other. This gives a piece of lead covered

[1] *J. A. M. A.*, 92: 1515, 1929.
[2] AM. J. SURG., 14: 419, 1931.

* Submitted for publication, March 10, 1932.

with squares, the side of each square being 1 cm. long with the corner of each square represented by a small perforation through the lead screen. In a lead plate covering an area of 15 × 18 inches, which is the average size of most pelvimeters described, it is necessary first to accurately measure off all of these squares and then drill or punch holes at the intersection of all of these lines. In a screen the size mentioned above this necessitates the drilling of 1803 holes. It is an extremely tedious procedure not only to drill this number of holes but also to get them accurately spaced. If one hole is out of place then four other distances are in error. The object in having this innumerable number of holes in the lead screen, which in turn show as dots on the exposed film, is to enable one to have a scale at the desired region to be measured, rather than to apply the region to be measured to a scale.

In the theoretical use of this type of pelvimeter one would imagine that, due to the fact that the *x*-rays are sprayed from the focal point of the *x*-ray tube in the form of a cone, as one moved away from the center of the film, the space between the dots in that region would be greater than the space between the dots near the center of the film. In the practical use of this method of roentgen pelvimetry I have always noticed that the dots on the film seem to be an equal distance from each other whether they were measured near the center or near the periphery of the film. This was noticed naturally in cases taken in the manner described by Jarcho where the lead plate was superimposed parallel to the film. I had always imagined and I believe others have also, that as one approached the edge of the film the space between the dots would become greater.

I discussed this matter with Prof. E. B. Skinner, head of the department of mathematics at the University of Wisconsin, and he wrote me as follows: "I found the problem a rather interesting one as I had supposed that if you took the images on the film corresponding to a set of perforations of the plate which lie on the straight line that the distances of the successive points

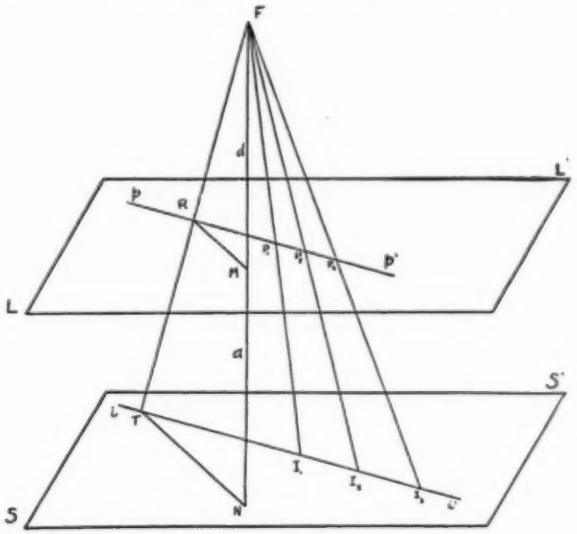

Fig. 1. Mathematical diagram.

on the film would increase as one goes out from the center of the cone. I find very much to my surprise that they do not increase, but that the distance between the images on any straight line are equal throughout the entire length of the line. Of course, if the spaces between any four neighboring points on the plate are equal, you could set up any number of lines which would have perforations equally spaced, and these would again appear as equally spaced points on the film. You are entirely correct in your surmise that any two pairs of equidistant points on the lead screen will appear on the film as two pairs of points equally distant. It does not make any difference as to the location of the points on the screen or the direction of the lines joining them."

Prof. Skinner then submitted the following, namely, that when a lead screen such as described was superimposed parallel to an *x*-ray film and an exposure made, all the dots appearing on the film along all the lines will be an equal distance apart.

Let F be the focus of the *x*-ray, LL the lead screen, and ss′ the film parallel to the screen. If the film is perforated so that each of four neighboring perforations is at the

vertices of a square, a line pp′ (Fig. 1) drawn through any two perforations of the screen will go through other perforations of

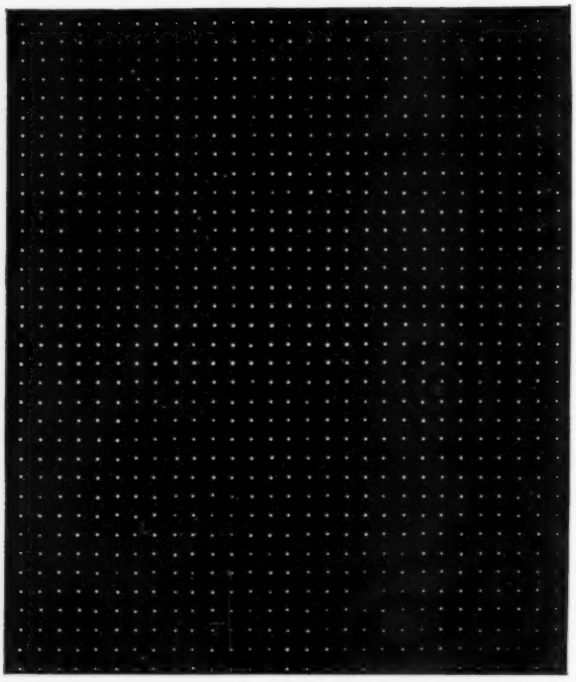

Fig. 2. Type of scale superimposed on film as made by present type of roentgen pelvimeter.

the network and the perforations on this line will be equally spaced since they are at the vertices of equal rectangles.

I. Let P_1, P_2, P_3 be the perforations along the diagonal line pp′ of the screen, and I_1, I_2, I_3 their images on the film. Then *the images* I_1, I_2, I_3 *are equally spaced along the line ii′ of the film.* For the triangles FP_1P_3 and FL_1I_3 are similar and the line FP_2I_2 which bisects P_1P_3 must also bisect I_1I_3; that is, $I_1I_2 = I_2I_3$. From this fact it follows that any pair of equal lines on the screen would reappear as a pair of equal lines on the film. This enables us to say that any configuration on the screen is reproduced exactly, so far as shape is concerned, on the film, and that the images on the film of all lines on the screen will be enlarged in the *same* ratio.

II. To find the ratio of enlargement, we draw the line FM perpendicular to the screen cutting the screen at M and the film at N and also draw the line FR perpendicular to the line pp′. This line extended will cut the line ii′ at a point T and will be perpendicular to it at that point. Let d = FM be the distance from the focus to the screen and a = MN the distance between the screen and the film.

The triangles FMR and FNT are similar with right angles at M and N. It follows that $\frac{a+d}{d} = \frac{FT}{FR}$. But from the pairs of similar triangles FRP_1 and FTI_1 and FP_1P_2 and FI_1I_2, we have

$$\frac{FT}{FR} = \frac{FI_1}{FP_1} = \frac{I_1I_2}{P_1P_2}.$$

Then the ratio of enlargement is given by

$$\frac{I_1I_2}{P_1P_2} = \frac{a+d}{d} = 1 + \frac{a}{d}.$$

It follows that

$$I_1I_2 = \left(1 + \frac{a}{d}\right)P_1P_2.$$

The last equation enables us to compute the distance between any two image points on the film as soon as we know the distance between the corresponding perforations on the screen provided we know the distances of the screen and the film from the focus F.

For example, if the distance of the screen from the focus F is 30 inches, and the distance between the screen and the film is 6 inches, the length of any line l on the film will be

$$l = \left(1 + \frac{6}{30}\right)s = 1.2s,$$

where s is the distance between the corresponding points on the screen.

Since it is proved that under the conditions described, all dots on the film are an equal distance apart, as shown on Figure 2, it then follows that any row of dots could be used as a scale for all the measurements made in that plane. Therefore, there would be no necessity of using the innumerable dots which make up the scale covering the entire surface of the film. Instead of using the row of dots immediately in the region to be measured it is only necessary to transpose the region to be measured to the single scale and note the reading.

In the pelvimeter scale described all rows of dots have been eliminated except one line extending lengthwise through the

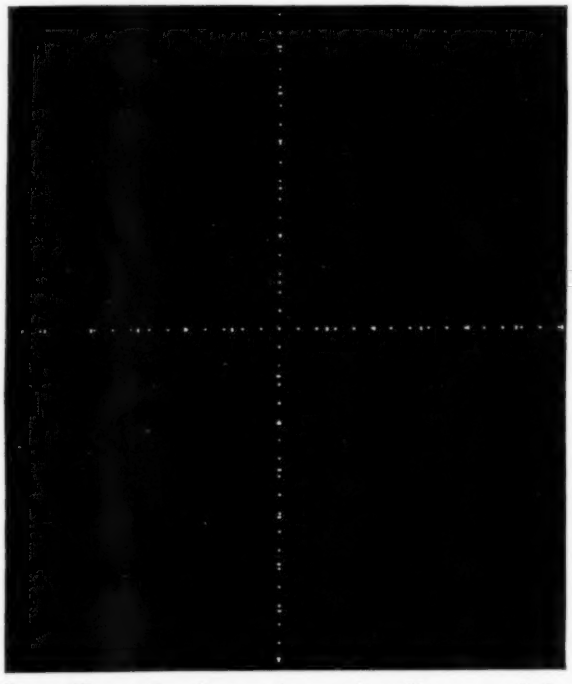

Fig. 3. Type of scale superimposed on film as made by simplified type of roentgen pelvimeter.

center of the lead plate and across line, such as is shown in Figure 3. If the pelvimeter were always used parallel to the film it would not be necessary to have more than one line of dots. However, if the pelvimeter is used on a slant, as in the manner described by Thoms, then it also becomes necessary to have a cross scale. This cross scale is so placed that the two lines of dots intersect each other at right angles in the center of the pelvimeter. If the pelvis is centered over the film when the radiograph is taken and the pelvimeter centered over the film when the scale is superimposed, then the scale will center near the middle of the superior opening of the pelvis. Then if the anterio-posterior diameter is measured on the longitudinal scale at the same level of the scale and the transverse diameter measured on the transverse scale, the pelvimeter can be used in cases where the superior strait of the pelvis is not kept parallel to the film. However, in cases where the superior strait is kept parallel to the film, such as in the technique described by Jarcho, the measurements can be made on either scale and on any part of the scale.

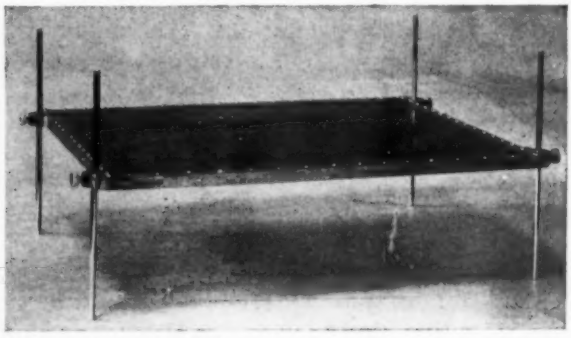

Fig. 4. General design and appearance of roentgen pelvimeter described.

This pelvimeter, as shown in Figure 4, has been constructed with four legs instead of the conventional type with two legs and feet, as used in the ones previously described. When used with a 14 × 17 inch cassette, these four legs just come over the edge of the cassette and therefore it is not difficult to center the scale on the film, in fact, it is almost impossible to do otherwise. When used with the Bucky diaphragm, the longitudinal and the transverse lines of the pelvimeter can be placed over the corresponding lines of the Bucky diaphragm and this will give a very accurate centering of the scale on the film. The legs and attachments have been made very accurate and the legs run very smoothly through the holes so that when the pelvimeter is held in position and the thumb screws loosened, the legs drop easily to the desired level. The lead plate used in the construction of this pelvimeter is very thin, being only 1/64th of an inch thick. The reason for using lead of this dimension is that the holes can be punched with a needle instead of drilled because punched holes in thin lead can be made more accurate than drilled holes in heavier lead. Punched holes can also be made smaller than drilled holes and will give a more accurate scale and one with less larger dots. The lead plate is mounted permanently with brass bands and screws to the wooden board which is constructed with a stile at each end to

prevent warping. When thin lead is used it is necessary to mount it permanently on the board in order to prevent it from bending and getting out of shape.

This type of pelvimeter, I believe, has several advantages over the older type. Due to the fact that it was made with a one line scale with very few holes in proportion to the number of holes on other pelvimeters, it is much easier and much less tedious to make; in fact, when made with thin lead as described and with the holes punched with a needle, the making of the scale is a very minor part of the procedure. In the construction of this type of pelvimeter there is very little measuring to be done and with punched holes and thin lead the scale can be made very accurate. Due to the fact that all measurements are made by applying the distance to be measured to the scale, oblique measurements can be made as easily as any other. In the use of this type of scale there is not the disfigurement of the film by the innumerable dots superimposed by other types of pelvimeters. This type of pelvimeter also permits the use of a double scale. It will be noted in Figure 3 that along the lines of the scale are placed double dots which represent inches, and readings, therefore, can be made in inches as well as in centimeters. It is also possible with this type of single line scale to superimpose more than one scale on the film and thereby take measurements at more than one level. In the procedure such as described by Jarcho, when pelvic measurements are made at the same time head measurements are taken, then both can be made on the same single film by superimposing a second scale at the level desired merely remembering which scale is to be used for each measurement.

While the changes in the roentgen pelvimeter here described are not radical changes over the older type, they still are of such a nature that the manner of construction and use of this type of pelvimeter is somewhat simplified. Therefore, I believe that anything of this nature which might enhance this type of work among radiologists and physicians in general is worthy of consideration.

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*Continued from p. 205.

ROUTINE METHOD OF ARTIFICIAL RESPIRATION FOR THE SURGICAL CLINIC*

W. Wayne Babcock, M.D., F.A.C.S.

PHILADELPHIA

ASPHYXIA during an operation, as a rule, is not conveniently or effectively treated by the routine methods of artificial respiration. Measures used in civil or industrial practice are adapted to the patient on the floor or ground rather than to the one on the operating table. The surgeon does not care to climb upon the operating table and bestride an open abdomen for the Howard method even though the viscera are covered by towels, or much less to invert the patient for the procedure of Schäfer or Marshall Hall. The arm movements of Silvester interfere with venoclysis and observations as to the movement of tidal air to and from the thorax. The tongue traction of Laborde is unreliable and if used, a dangerous delay in adopting adequate measures for artificial respiration may result.

In the surgical emergency there should be no delay, and the patient should remain on the operating table with the least possible change in position. The method should be positive and effective, and the manipulations used should not prevent convenient access to the mouth and jaws to maintain an open airway, to constantly record the tidal air movements and to give, if desired, inhalations of ammonia, oxygen, carbon dioxide or other substance.

Artificial respiration is not a gesture, it is an effect; and the surgeon should have constant evidence of its effectiveness. It should be feasible without producing infection, or causing other danger through an open abdominal cavity. It should not interfere with a coincident intravenous injection into a vein of the arm. If possible, it should permit the associated use of cardiac massage. The danger of fracture of the ribs from undue pressure upon the thorax should be minimal.

It is our observation that in the operative emergency, the surgeon usually resorts to the Silvester method, driving the anesthetist from the patient's head, as the patient's arms are moved violently up and down; thus a careful control of the jaws and tongue, the accurate observation of the air movements, and the convenient use of intravenous injection are prevented. Experience has convinced me that this is an undesirable method for use in the surgical clinic and like the pulmotor should pass into innocuous desuetude.

For over twenty years we have used the following routine. If cessation of respiration is feared or occurs, the anesthetist affixes a delicate wisp of cotton by a bit of adhesive plaster or collodion to the tip of the patient's nose. This hangs in front of the patient's nose and mouth and is a positive indicator of spontaneous or induced air movements. The patient's arms are extended alongside his head. A large pad is placed in the abdominal wound to prevent the extrusion of intestines, and the abdomen and chest are covered by a sterile towel or sheet. If the cotton indicator remains motionless, the operator standing on the right side facing the patient's head, clasps his hands together over the manubrium of the patient, his elbows and forearm coapting the lateral thoracic walls. With pressure of the hands, forearms and elbows back, down and in, aided to some degree by the weight of his body, which is swung upon the patient's chest, the operator produces expiration, at the same time watching the patient's face and noting the effect

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of his pressure upon the cotton indicator. The effect may be aided by pressure from the hands of an assistant placed under the operator's elbows. Inspiration, of course, results as the pressure is sharply released. The anesthetist maintains an open airway by keeping the mandible and tongue forward, notes the movements of the tidal air produced, watches the pupils and the carotid, temporal or radial pulse and is prepared to administer carbon dioxide oxygen, or other restorative.

Fig. 1. Artificial respiration by intermittent compression of anterior thoracic wall. Patient's arms extended alongside head. Operator's hands are clasped over patient's sternum, and expiration, proved by cotton indicator affixed to patient's nose, is produced by downward, backward and inward pressure with hands, forearms and elbows. Meanwhile epinephrinized saline, guided by reaction upon pulse, is being given.

Nothing should be given by inhalation, however, until the operator has proved that he can produce adequate movements of air to and from the patient's lungs. The cotton indicator is invaluable in showing the efficiency of the operator. For example, in a case in which a patient was kept alive for about five hours by the method, using relays of assistants and medical students, I found that certain men were unable without special training to move the tidal air. The anesthetist watching at the patient's head and maintaining an open airway by mouth gag or tongue forceps, should not only see the cotton move but also hear the rush of air as it enters and leaves the patient's chest. To forestall circulatory failure, it is wise for an assistant to promptly start an injection of epinephrinized saline solution into a convenient vein in the patient's arm or leg.

Compression methods for the production of artificial respiration, while usually very satisfactory, at times will fail. In certain patients with emphysema, a heavy barrel shaped chest, a pleural effusion or extensive disease of the lungs, it is not possible to produce artificial respiration by compression of the chest alone. The senile chest with calcified costal cartilages has limited compressibility. The same thing is occasionally true even in children. In a young child and also in a heavy chested athletic young man, I was unable to sufficiently move the tidal air, as shown by the indicator or by audible currents of air. In such a case what should be done?

It is probable that the Silvester method or the Marshall-Hall method will also be ineffective, so therefore, we immediately abandon all compressive methods, and use forced inspiration by mouth to mouth insufflation. The operator steps to the side

of the patient's head, compresses his nose with one hand and with the other makes pressure over his epigastrium to prevent

Fig. 2. If cotton indicator shows that sufficient air movement to and from chest does not occur from intermittent compression, mouth to mouth insufflation is promptly substituted. Patient's mouth, held open by gag, is covered by four layers of gauze, and nostrils and stomach are compressed as operator intermittently inflates lungs. During inflation chest can be seen to expand; during expiration rush of escaping air is heard.

distention of the stomach by air. The patient's mouth having been covered by two to four layers of gauze or a thin towel, the operator takes a deep inspiration, immediately applies his widely opened mouth over that of the patient and makes forcible exhalation. If properly performed the patient's chest will be observed to expand as the air is blown into his mouth and at the end of the insufflation, as the operator raised his head, a rush of air will be heard coming from the patient's lungs which is increased by an associated manual compression of the chest. For an adult patient, the mouth to mouth insufflation is safe, as the pressure in the patient's lungs cannot exceed or even equal that in the operator's thorax. In children, however, care should be taken that undue pressure is not produced, remembering the deaths which have followed the rupture of alveoli in infants or adults from the use of the pulmotor. In two cases, before we realized the effectiveness of simple mouth to mouth insufflation, we produced forced inspiration by intermittently blowing through a tube placed over a tracheotomy opening. Mouth to mouth insufflation has displaced the more complicated methods of forced artificial respiration in our clinic, when the simple compression of the chest has failed, and has saved at least four lives. But why not use oxygen or oxygen-carbon dioxide through the face piece of the anesthesia machine? Because it is not fool proof. In the desperate emergency there is no time to make sure that the machine is properly delivering only pure oxygen and carbon dioxide in the right proportions. I saw one patient die from time lost as the anesthetist insisted on proving how effective his apparatus was for purposes of resuscitation. Others may find as Stanley did, when it is too late to help the patient, that a nitrous oxide tank had been placed for that of oxygen. The operators' lungs are not subject to such error. They will deliver only oxygen and carbon dioxide. Usually it is necessary to use a mouth gag and occasionally hold the tongue forward and to the angle of the mouth by a forceps, tenaculum or thread during the insufflation. An alternative method of preventing the entrance of air into the stomach is to press the larynx back against the esophagus.

If tidal air is properly moved by the thoracic compression alone, the operator and his assistant may maintain the sterility of gloves and gowns, being ready to immediately complete the operation or, should such prove necessary, to introduce the hand in the abdominal wound for cardiac massage. The respirations produced should not exceed a rate of fourteen to sixteen per minute.

FIG. 3. If heart has stopped and does not respond to an intracardiac injection of epinephrine, index finger is carried through a 2 cm. incision in third left intercostal space and hooked about heart which is compressed and massaged against overlying chest wall. Sterile wet gauze wrapped about base of finger prevents entrance of air into thorax.

Methods of artificial respiration are seriously handicapped by regurgitant vomiting. The gastric secretions may flood into the pharynx or mouth and the patient be drowned by his own fluids. I have seen one patient die from this cause. On the regurgitation of gastric liquids the head of the patient should be markedly lowered, and if large quantities of fluid well into the mouth, as occurs in ileus, a tracheotomy should quickly be done and the respirations conducted through the tracheal opening. Of course the danger of regurgitation may be reduced by gastric lavage before the anesthetic is given, but at times the fluids continue to well back from the duodenum and the lavage is insufficient.

In respiratory failure and before the respirations have entirely ceased a powerful stimulus may be obtained by the inhalation of oxygen containing 10 per cent of carbon dioxide. Such inhalation should not prevent an early resort to artificial respiration when it is needed. In any case, the circulation should constantly be watched. The difficulties of resuscitation are enormously increased by circulatory failure and the patient will surely die if the heart absolutely stops for more than seven minutes. An early resort to intravascular infusion with epinephrinized saline insures against cardiac arrest, and an intravenous outfit should always be ready for instant use in every operating room. The smallest quantity of epinephrine solution that will produce the desired effect (it may be ½ minim, it may be 100 minims of the 1:1000 solution) should be used. We start with 200 c.c. of saline solution containing 10 minims of the standard 1:1000 epinephrine solution. The instant the pulse responds, even though but a small fraction of the epinephrine has entered the vein, the flow is arrested to be resumed intermittently later as required. In this

way a prolonged effect may be produced. If there is no response the percentage of epinephrine in the saline is very rapidly increased until a response is evoked. An excess of epinephrine is harmful, putting at times an enormous strain upon the heart and vessels and being followed by corresponding secondary circulatory depression.

With absolute arrest of the heart, a direct local stimulus is usually necessary to carry the epinephrine into coronaries where it becomes effective. With the open abdomen subdiaphragmatic cardiac massage is easily produced. The operator should be careful not to have the left lobe of the liver interposed between the internal hand and the diaphragm. In about 20 cases of cardiac massage the subdiaphragmatic method was the only one that gave me an enduring effect. Occasionally, I have found it will fail where a transthoracic massage will stimulate the heart to action. It is not necessary to turn back a flap of the chest wall for transthoracic cardiac massage. A stab is made through the left third interspace 2 cm. from the sternum (to avoid the internal mammary artery) the finger introduced into the chest as the knife is withdrawn and curled about the left border of the heart, which is rhythmically compressed against the overlying chest wall by flexing the finger.

The intraventricular injection of epinephrine gives a violent stimulus to the heart that is very effective and has largely displaced cardiac massage. A 22 gauge needle 9 cm. long is entered at the left border of the sternum in the third interspace, carried in and mesially until the resistance of the venticular wall is past, aspirated to prove that the point of the needle is in the free ventricular cavity and the withdrawn blood reinjected with the 5 or 10 minims of epinephrine in the Luer syringe. These drastic procedures should rarely be necessary. During the period of dire emergency the subcutaneous injection of stimulants may divert the attendants from quicker and more effective measures. Therefore, we avoid them. Finally it may be noted, that the need of an intracardiac injection during an operation usually indicates that the patient has not been watched with sufficient care, or that the proper prophylactic measures were not instituted sufficiently early.

SUMMARY

1. The conventional methods of artificial respiration are not well adapted to operating room practice.

2. The operator should use no method of artificial respiration that does not cause adequate quantities of air to enter and leave the patient's chest. Artificial respiration is not a gesture, it is an effect.

3. Efforts at artificial respiration should be continued if necessary for many hours, or at least until the heart no longer responds to even the most powerful direct stimulus. The patient should be kept warm.

4. A time tested and effective plan for routine use is here given.

CLINICAL SIGNIFICANCE OF

THE FORM & FUNCTIONS OF THE DORSAL ROOTS IN SPINAL ANESTHESIA*

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THE purpose of this paper is to correlate some of the known facts of the anatomy and physiology of one division of the sensory pathway so that one can formulate on the basis of these facts a working hypothesis which should explain some of the physiological disturbances produced by spinal anesthesia. The interpretations submitted here have been deduced from clinical experience only, not physiological experiment. This type of anesthesia does not lend itself readily to animal experimentation as there is the greatest divergence between the highly organized nervous system of man and that of the lower vertebrates.

Since spinal anesthesia is usually produced by the introduction of a neurotropic drug in the subarachnoid space, generally in the lower lumbar region; its local and immediate actions must necessarily be confined in this space which in this region is filled by the roots of the spinal nerves that go to make up the cauda equina. Therefore, if we wish to study the specific action of this neurotropic drug, it is essentially important that we should know very minutely the anatomy of the structures in the subarachnoid cavity. However, in my opinion, it is not necessary to discuss the anatomy of the cord or of the ventral nerve roots because we can explain all the physiological phenomena of spinal anesthesia by the action of the drug on the dorsal roots alone.

It is true that this view is not held by the majority of writers on this subject; Labat states that "the sensory and motor roots being apart from each other, the action is greater on the motor fibers than when injecting the mixed nerve trunks, even by the endoneural method, outside the spine. Motor paralysis is the natural consequence of intraspinal block." This point of view is also held by that brilliant exponent of spinal anesthesia, Babcock. I shall attempt to show that this statement of Labat cannot be sustained on either pharmacological or physiological grounds.

The sensory neurone system is much more complex than is the motor neurone system. In its simplest form it consists of at least four neurones while the simpler motor neurone system is made up of only two, a lower and an upper neurone. To this complexity of the sensory system we can attribute its vulnerability to the action of all types of anesthetic drugs. Hitzig and Bernstein have established the fact that everywhere in the central nervous system the motor mechanism is particularly resistant to narcosis. Therefore, it is not surprising that local anesthetic drugs of the benzoyl group, of which novocaine is deservedly the most popular, affect almost exclusively the sensory elements of the nervous system. Independent experiments by Koch, Dixon and Santesson proved this many years ago. The pharmacotropic action of novocaine for sensory elements is so pronounced that its conduct may be likened to that of a vital stain, picking out sensory fibers and avoiding motor filaments. The selective affinity for certain nerve elements is a feature common to many other neurotropic drugs as exemplified by adrenalin, acetylcholine, nicotine, curare and so on. It would be reasonable to postu-

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late from the pharmacodynamic evidence of the elective affinity of the cocaine group for sensory nerve tissues that the brunt of the action of novocaine in the subarachnoid cavity would be on the dorsal roots. From this standpoint we are justified in assuming that the tendency of novocaine would be that of blocking the posterior nerve roots and permitting conduction through the anterior nerve roots.

This statement may still appear, on the surface, rather paradoxical, for it is known that spinal anesthesia does produce various degrees of so-called motor paralysis which is especially marked in the lower limbs. However, let us analyze this type of paralysis from the standpoint of the physiology of the afferent nervous system. We have learned from the physiologists how tremendously complicated muscular movement really is, and how, in order to coordinate these movements, there must be a constant stream of informative impulses flowing along the posterior roots to the portion of the brain which initiates the movement of locomotion. The significance of this important general principle that the essential basis of all purposeful and effective motor activity is to be found in accurate sensory information seems to have been overlooked by many authors on spinal anesthesia. The part played by afferent impressions in the coordination of muscular movement was emphasized several years ago by Starling. He was the first to point out that experimental section proximal to the ganglia of all the posterior nerve roots supplying a limb produces a functional, though not an actual, paralysis of the muscles of that limb. Furthermore, it has been shown that postural activity of muscles (muscle tone) depends primarily on the integrity of the posterior nerve roots. If these impulses from the corresponding muscles are not received, loss of tone results; the muscles become flabby and the limb can be placed in unnatural positions and excessive movement is permitted at the joints without producing discomfort. Obviously in Starling's experiment there develops anesthesia of the entire limb for all forms of sensation because the sensory impulses from the periphery are cut off from the spinal cord. This description of some of the results following experimental section of the posterior nerve roots is applicable to the picture produced by spinal anesthesia except that the latter procedure produces only a temporary section of these same fibers. It is apparent, therefore, that the presence of paralysis of the lower limbs in spinal anesthesia is not in any sense of the word indicative that the motor roots have been affected by the drug.

It is not essential in this paper to consider the form and function of the spinal cord because we have no tangible evidence that spinal anesthesia has any direct influence on this important structure. It may appear on casual examination that this form of anesthesia produces a physiological section of the cord. A careful neurological investigation will show, however, a radicular type of block.

In order to understand spinal anesthesia we must have a clear conception of the minute anatomy of the dorsal nerve roots proximal to the ganglia. I hope to show that a careful scrutiny of the histology of this region of the dorsal nerve roots will elucidate the selectivity of novocaine when introduced intrathecally. The accurate researches of Ranson have done much to clarify the anatomy of the dorsal nerve roots. In 1912, Ranson modified the Cajal silver technique in such a way as to produce a differential stain of non-myelinated fibers and applied to the method the term "pyridine silver technique." As a result of this procedure, he has been able to demonstrate the existence of a large number of non-myelinated fibers in the dorsal roots of spinal nerves. For many years the prevalent view has been that both the dorsal and ventral roots of the spinal nerves are made up exclusively of myelinated fibers. As to the function of the myelin sheath in medullated nerve fibers very little is known. Many speculations have been indulged in with regard to its

function but practically nothing that is certain can be said upon this point. It has been supposed by some to act as a sort of insulation preventing contact between neighboring axis cylinders and thus insuring better conduction. But against this view it may be urged that we have no proof that the non-medullated fibers do not conduct equally as well. There is, however, some evidence that this sheath plays an important part in the chemical process involved in the act of nervous conduction. Furthermore, the fibers which possess a medullary sheath are more resistant to defective blood supply and toxic agents. It is probable that the myelin sheath serves as a source of nutrition to the enclosed axis cylinder, which, in the greater part of its course is far removed from its trophic center, namely, the cell from which it is an outgrowth. This so-called trophic function of the myelin sheath has a certain basis in the fact that the myelin sheath is larger in those fibers that have the longest course, the size of the sheath in fact increasing with that of the axis cylinder. In describing the dorsal nerve roots, Ranson notes that the fibers that are not myelinated are very small and also have a relatively short course. This, surely, fits in with the idea of the probable trophic function of the myelin sheath.

Although Woollard states that Ranson's observations have not won general acceptance on either anatomical or physiological grounds, his work, however, has been confirmed by Ingvar and accepted by Hauptman. Ranson thinks that these non-myelinated fibers can only be shown by his modified stain and, therefore, most anatomists have failed to see them. Also there has naturally been reluctance to accept a radical change like this in fundamental ideas. However, the evidence which he presents is very convincing when viewed from the spinal anesthetic standpoint. He describes the intrathecal part of the dorsal roots in the following manner:

The central end of a dorsal root breaks up into many rootlets or filaments which enter the spinal cord in linear order along the line of the posterior lateral sulcus. As it enters the cord each filament can be seen to separate into a larger medial and a much smaller lateral division. The fibers of the medial division are of relatively large caliber and run over the tip of the posterior column into the posterior funiculus. The fibers of the lateral division are fine and enter a small fascicle which lies along the apex of the posterior column, the fasciculus dorso-lateralis or tract of Lissauer. Very soon after their entrance into the cord each dorsal root fiber divides in the manner of a Y into a larger ascending and shorter descending branch.

He maintains that the fibers of the lateral division of the dorsal roots are all very fine and that the majority are non-myelinated. Those of the medial division, on the other hand, are practically all myelinated.

Having considered this conception of the morphology of the dorsal roots, it will now be advisable to discuss the variety of sensory impulses carried by these different types of nerve roots. In 1822 the French physiologist, Magendie, after a vast amount of research gave to the world his fundamental dictum that the dorsal roots of the spinal nerves carry all forms of sensation. In 1900, Sherrington classified the filaments of the dorsal roots from a functional point of view, into three broad groups. In this classification he designates those dorsal fibers carrying impulses from the viscera as interoceptive and subdivides the somatic afferent fibers into exteroceptive and proprioceptive groups. The exteroceptive fibers carry impulses from the surface of the body. These fibers, therefore, are actuated exclusively by external stimuli. The impulses produced in this way are carried by these special fibers to the spinal cord and then relayed to the cerebral cortex where they are interpreted as the sensation of heat, cold, pain and touch.

The proprioceptive fibers carry nerve impulses which on reaching the central nervous system give information concerning the tension of the muscles and the relative position of various parts of the body. For the most part, however, these impulses do not rise into consciousness but

serve for the subconscious control of muscular activity. There are, therefore, two main groups of afferent somatic impressions that eventually excite sensation, namely those that come from the skin and those that originate in the deeper or proprioceptive structures of the body. The much greater importance of the latter in determining the activity and reactions of the body must not be forgotten; a limb with cutaneous anesthesia may be quite a useful member but complete loss of all forms of deep sensations would make it worthless to the individual.

It may be noted here that the observations on which Head and his co-workers attempted to subdivide cutaneous sensations into protopathic and epicritic groups have no bearing on the problem of sensory dissociation in spinal block. Thus, all forms of touch, whether crude or precise, all forms of temperature whether extremes of heat and cold, or intermediate grades of temperature and all forms of pain are conveyed by exteroceptive fibers. These exteroceptive fibers having a very short course terminate in the dorsal horns around cells whose axones go to make up the spinothalamic fibers in the opposite ventrolateral column.

The coarse medullated fibers of the mesial division of the dorsal roots carry proprioceptive impulses. They ascend without interruption through the dorsal columns to the medulla oblongata.

We are now in a position to develop a coherent idea of the anatomy of sensation as applied to the central processes of the primary sensory neurones on their way to the posterior lateral sulcus of the spinal medulla. Ranson assumes that the small non-medullated fibers, previously described, carry exteroceptive impulses out of which the sensation of heat, cold, pain and some forms of touch are elaborated. His conclusions have been confirmed recently by Gasser, Bishop and Erlanger using the cathode ray oscillograph.

Physiological investigations by these observers have shown that the action currents in the dorsal roots are very heterogenous, whereas in the ventral roots they are more or less homogenous. Analyses of these waves have shown that the dorsal roots are composed of at least four different types of fibers (alpha, beta, gamma, delta). The ventral roots are made up only of alpha fibers. These four components of the dorsal roots are associated with different functions as shown by their histological and physiological characteristics. Thus the alpha fibers have the largest cross section, the greatest velocity of nervous impulses, the lowest threshold to stimulation and the shortest absolute and relative refractory periods, whilst the beta, gamma and delta fibers have progressively smaller diameters, lower velocities, higher thresholds and larger refractory periods. This natural group of the velocities of impulse propagation in these different types of axones falls into accord with the observations of Lapique and his colleagues on the varying chronaxies of nerve trunks. Lovatt Evans has suggested that motor impulses to muscles, sensory impressions and afferent depressor impulses belong to the alpha class; the beta sensory impressions evoke respiratory reflexes and the gamma pressor reflexes. The delta fibers correspond to the fine non-medullated fibers of the dorsal roots which Ranson has been able to stain by his silver pyridine method. Since the four types of fibers have different morphological and functional characteristics, it would be safe to postulate that their behavior under the influence of novocaine would also differ.

Having considered in detail some of the known anatomical and physiological data of the areas affected by the intrathecal dose of novocaine we are now able to understand and interpret some of the clinical findings observed in routine spinal block. The physical and functional differences in the posterior root fibers afford a very practical explanation of the dissociation of sensation produced by spinal anesthesia. On a purely physical basis it would not be difficult to account for the exquisite

sensitivity of the exteroceptive fibers to very dilute solutions of novocaine because of the small size of the fibers and the absence of the insulating coat of myelin, whereas the larger and well insulated fibers of the proprioceptive group should offer greater resistance to the effect of very dilute solutions. This assumption can be verified readily by giving a small dose of novocaine intraspinally. For example, if 40 mg. of novocaine dissolved in 4 c.c. of distilled water be slowly introduced intrathecally at the level of the fourth lumbar interspace only the exteroceptive and interoceptive fibers below the level of the twelfth thoracic segment will be blocked. Within five minutes analgesia and thermoanesthesia will develop in the area supplied by these segments with no appreciable disturbance of deep sensibility and hence no paralysis or ataxia of the limbs, the tendon reflexes not being abolished. In this experiment the concentration of the drug is not sufficient to cut off all the afferent impulses and, therefore, we get the type of dissociated anesthesia as seen in a typical case of syringomyelia.

However, if 160 mg. of novocaine dissolved in 1 c.c. of distilled water be administered in the same manner a different condition will exist. Complete anesthesia and paralysis of the lower half of the body supervenes. There is a zone of analgesia and thermoanesthesia above the area of complete anesthesia. In this case we obtain a complete block in the region where the drug was first introduced and a partial block where dilution has occurred. In this way the relative safety of high spinal anesthesia can be explained. The cutting off of the exteroceptive and some of the interoceptive impulses does not break the reflex arc and hence no interruption of function of the affected segments. If the proprioceptive impulses are also blocked we get the usual effect of complete section of the posterior roots, viz., paralysis, ataxia, and anesthesia.

As a result of the tremendous increase in the use of spinal anesthesia in the past five years, the literature, especially on this Continent, has been flooded with articles on this subject. Consequently, it is rather difficult for the novice in this field to differentiate between worthless and useful literature. Although the outstanding contributions of Babcock, Labat and Koster have not had much to do with this increase in popularity it is to them that the serious student of this subject must turn. While Koster is relatively a recent convert to this method he has, by his original laboratory experiments supported by a relatively large personal experience, done much to stimulate an interest in the physiological side of spinal block. His revision of some of the older functional conceptions has changed the aspect of this subject. Nevertheless, some of his conclusions are open to criticism.

Koster's explanation of the absence of serious cardiac and respiratory impairment in high spinal anesthesia is based upon the following assumption, namely, that the property of excitability of nerve fibers is more resistant to the action of the benzoyl group than the conductivity of these nerve fibers. Various workers have shown that where, by progressive action of a narcotic a stretch of nerve has just failed to conduct to the muscle an impulse generated at the central end of the nerve, strong stimuli applied within the narcotized area will still provoke a contraction especially if applied at the peripheral part of the narcotized stretch. This appears to support the view that conductivity of nerve fiber is more easily affected by anesthetic drugs than the excitability factor. However, Kato and Forbes, independently, have shown that this apparent difference between conductivity and excitability is dependent upon the fact that very strong stimuli can spread far along the nerve, sometimes 30 mm., so that in these experiments such a stimulus can often affect portions of the nerve outside the chamber. When mechanical stimuli are used instead of electrical ones, the response falls simultaneously to stimuli above the chamber and at all points within

it. It seems unlikely that any hypothesis would be sound based upon physiological experiments, the interpretation of which is so controversial. Therefore, Koster's statement, "that spinal anesthesia for surgery of the head, neck and thorax is relatively safe because it is possible to have anesthetic action to the point of interruption of sensory impulses in nerve fiber and yet be far from a complete depression of excitability of nerve cell" is not supported by the very experimental work from which he draws his analogy. In my opinion high spinal anesthesia owes its safety to a low introduction of a concentrated solution of novocaine which, when it reaches the upper nerve roots becomes so dilute that it is only able to affect the small non-myelinated exteroceptive and interoceptive fibers of the upper dorsal roots. Personal observations from a number of high spinals have demonstrated that in the head, neck and thorax the sensory loss is of the dissociated type as found in syringomyelia, that is, pain and thermic sense are lost, deep sensibility is retained while in the abdomen, pelvis and lower extremities there is a complete loss of all forms of sensation. There is in high spinal anesthesia an interruption of the exteroceptive and interoceptive impulses in the upper third of the body while in the lower two-thirds there is an interruption of the proprioceptive as well as the exteroceptive and interoceptive impulses. In other words there is analgesia and thermoanesthesia in the upper third and complete anesthesia and muscular relaxation in the lower two-thirds of the body.

Let us now consider a more difficult part of the subject, namely the arrangement of the afferent neurones of the involuntary nervous system. The knowledge of this part of the involuntary nervous system is still very meager. Anatomical studies show that the visceral afferent fibers are chiefly medullated and of varying size with an admixture of a considerable number of non-myelinated fibers, all of which have their cell stations in the dorsal root ganglia. From the ganglia central processes are sent into the spinal gray matter.

In describing the physiology of spinal block most authors ignore the afferent side of the autonomic system stressing only the supposed effect of the drug upon the white rami communicantes. It is interesting to note here that anatomically the white rami are not strictly in the subarachnoid space, although the fibers that go to make up part of the white rami are, but these fibers have not been given any special anatomical designation, being known only as preganglionic efferent fibers. Hence it would be more precise not to use the term white rami in describing the effect of novocaine on the sympathetic nervous system. I feel that we can explain all the sympathetic effects of spinal block by the theory that the drug acts only on the afferent side of the autonomic nervous system. There is reason to believe that under normal conditions the autonomic fibers are always excited reflexly although normally we receive no conscious sensations from most of our viscera. The bladder and the rectum are exceptions to this rule because at various intervals we receive information concerning the state of tension in these organs. The afferent impulses from the viscera are chiefly expended in reflexly affecting the activity of various involuntary structures such as the blood vessels, glands and smooth muscle fibers. If these afferent impulses are cut off it must follow that the sympathetic system would be paralyzed. Anatomically, it is known that most of these afferent fibers are non-medullated while those of the efferent side of the autonomic group, namely, the preganglionic fibers that go to make up the white rami are all medullated. It is not difficult to assume that novocaine attacks by preference these non-medullated fibers and in this way breaks the reflex arc of the sympathetic nervous system. It would be beyond the scope of this paper to discuss in detail the physiological derangements produced by interfering with the sympathetic reflex arc. This temporary disorganization of the autonomic nervous

system is one of the disconcerting features of spinal block. The removal of sympathetic control, as Cannon has shown in his sympathectomized animal experiments, certainly places the circulatory and respiratory mechanisms at a disadvantage. We can, therefore, say that the modern trend of the exhibition of sympathomimetic drugs such as adrenalin and ephedrine, in an attempt to reinforce the depressed sympathecoadrenalin system, is based probably upon sound physiological principles.

CONCLUSIONS

First, that all the disturbances produced in this form of anesthesia can be explained by the effect of the drug on the afferent side of the nervous system.

Second, that there is anatomical, physiological, pharmacological and clinical evidence in support of this view.

Third, that spinal anesthesia is a pure, posterior, radicular block of variable intensity.

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PRESENT STATUS OF MANAGEMENT OF CARCINOMA OF THE BREAST*

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OF the many problems confronting the physician of today, none presents a more gloomy outlook than the subject of cancer. Over 100,000 people die of cancer every year in the continental United States. Cancer of the breast is responsible for 10,000 of these deaths. This unduly large percentage might be averted by timely treatment.

In the present state of our knowledge the best method of treatment is dependent upon early diagnosis of cancer. Our objective is to get the disease while it is still local and susceptible of complete removal.

Much information has been circulated among the laity which has resulted in getting patients to consult their physicians earlier.

The physician should become acquainted with the early signs and symptoms of the disease. The old cases with fixation of the breast, large axillary glands, ulceration, and cachexia call for the services of the undertaker rather than the surgeon.

In considering a breast lesion it is important to remember that (1) cancer is the most common cause of a definite lump in the breast of a non-lactating woman over twenty-five years of age; and that (2) any such lump should be regarded as cancer until proved otherwise.

The more certain you are that the condition is cancer the more advanced is the disease.

Cancer should be suspected when there is: (1) any lump in or near the breast or arm-pit; (2) any discharge, whether bloody or not, from the nipple; (3) any acquired distortion or inversion of the nipple; (4) any appreciable enlargement or diminution in the size of the breast; (5) any abrasion or ulceration near the nipple.

The earliest clinical evidence of cancer of the breast is obtained by palpation, and consists in the finding of a definite, irregular, hard, non-sensitive lump that cannot be moved independently of the breast and that shades away gradually into the surrounding breast tissue without any clearly defined line between tumor and breast tissue. Oftentimes in moving the skin over the tumor some dimpling may be observed. Adenomatous and cystic lesions are sharply circumscribed and are freely movable in the breast tissue. A small percentage of these benign lesions tend to become malignant. They may be left alone before the age of twenty-five, but should all be removed thereafter by simple excision of the tumor.

Multiple masses in one or both breasts are rather characteristic of chronic cystic mastitis. This condition may develop malignant changes in some of the affected areas, so the best treatment is by excision of the entire breast.

Enlarged axillary lymph nodes may be present in benign breast lesions and may not be demonstrable before operation in many cases of late cancer, so their presence or absence is not a vital sign in differentiating a benign from a malignant lesion. However, enlarged axillary nodes under the edge of the pectoralis major muscle should cause a diligent search for the presence of cancer of the breast, unless there is an obvious pyogenic infection.

A small percentage of breast cancers are accompanied by a bloody discharge from the nipple, and it is usually due to a pri-

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mary papillary epithelioma of a duct or to benign intracystic papilloma. The latter lesion has a tendency to become malignant, so both should be subjected to early operation. Bloody discharge may be rarely encountered in other benign lesions not requiring operation, but in doubtful cases exploratory incision should be done.

Eczematous involvement of the nipple or areola may bring the patient to the physician. The pathology of Paget's disease of the breast is now thoroughly understood. It is a carcinoma beginning in the milk ducts and extending to the skin around the nipple.[1] The eczema is secondary to the carcinoma, and not *vice versa*. Paget's disease of the breast must be differentiated from simple eczema. Simple eczema is not of as long standing and disappears under proper treatment. True Paget's disease of the breast is treated like any other carcinoma of the breast, that is, by radical operation. If there is any doubt as to the diagnosis an immediate biopsy should be done.

Any inequality in the size of the breast due to cancer will be accompanied by definite evidence of cancer. However, inequality in the size of the breasts may be present in the absence of cancer.

The earlier the lesion and therefore the more uncertain the diagnosis the better is the prospect of cure.

PROGNOSIS

We should not speak of cure in referring to cancer cases. We may speak of arrests only, as recurrences may occur at any time. I only recently learned of a woman who died of recurrences and metastases seventeen years after a radical operation.

The average duration of life of patients suffering from all types of unoperated cancer of the breast is from 3.2 years to 4 years after discovery of the tumor. This average includes patients of all ages.[2]

Daland[3] of Massachusetts General Hospital says that about 22 per cent of all patients having untreated cases of carcinoma of the breast are alive at the end of five years.

Reports of arrests of less than five years' duration are of no value for statistical purposes as untreated cases have an average duration of life of three to five years.

The average duration of life after a radical operation is about five years. There is a gain of about one year between operated and unoperated cases.

A radical breast operation done in the presence of contraindications such as fixation of the tumor to the chest wall, metastases, fixation of axillary nodes, involvement of supraclavicular nodes, or edema of the arm, shortens the life of the patient. Such patients live longer without any operation, and a simple mastectomy gives a longer lease of life than a radical operation.

Analysis of statistics of results in breast cancer cases is very difficult. Most men simply give their average results in all cases. The presence or absence of axillary nodes, the type of carcinoma, and the use of radiation methods preoperatively or postoperatively, all have a bearing on the outcome. All these factors should be included in a statistical study of breast cancer if the study is to be of real value.

Bunts[4] reports 24.1 per cent of five-year cures, 9.5 per cent of ten-year cures, and 4.1 per cent of fifteen-year cures, of 867 traced cases; 20.1 per cent five-year cures in cases with axillary glands involved; 35.4 per cent five-year cures in cases with axillary glands not involved.

A recently published Leeds Hospital report[5] shows that 90 per cent of patients with breast cancer operated on before the lymph nodes were involved lived at least ten years after the operation.

The degree of malignancy is as important in determining the prognosis as is the presence or absence of axillary lymph nodes. Greenough,[6] in a recent study of breast cases, has shown that a low degree of malignancy with involved lymph nodes is compatible with a longer lease on life

than a high degree of malignancy with uninvolved lymph nodes.

Broders,[7] Sistrunk and McCarthy[8] have made important contributions to this subject in showing how the degree of cellular differentiation, hyalinization, and fibrosis, are the greatest factors in determining the prognosis in these cases.

Gottesman[2] has recently advocated doing a biopsy at the time of operation to determine the degree of malignancy. If a high degree of malignancy is found he advises preoperative radiation to convert the high degree of malignancy into one of lesser degree.

An average of the statistics of results in cancer of the breast cases of 32 surgeons and clinics compiled from the literature by Portman[9] gives 28.8 per cent five-year cures, the highest being 52.1 per cent five-year cures by Watson-Cheyne; the lowest, 15.9 per cent five-year cures by Rahm. The Cleveland Clinic Series shows 23.1 per cent five-year cures with surgery alone, and 35.8 per cent five-year cures with surgery and postoperative *x*-ray treatment.

Dr. A. C. Scott, Sr. of Temple, Texas, reports 72.7 per cent five-year cures in 11 cases; 2 out of 5 patients, or 40 per cent of cases with axillary nodes involved, were living at the end of five years; 100 per cent (6 cases) without axillary nodes involved were living at the end of five years. Dr. Scott does the radical operation using the electric cautery for incision and block dissection. He has done over 700 cautery breast operations.

Oliver[10] reports results in 88 cases; 46 radical and 10 palliative operations were performed. Only a few patients were found living at the end of three years. These were ward cases at Cook County Hospital of Chicago. He attributes the poor results to the advanced stage of the disease and to the poor general resistance of these patients on entrance to the hospital.

Bevan[11] says that 75 or 80 per cent of breast cancer cases can be permanently cured if the disease is limited to the breast, whereas, if at operation the axillary glands are found involved, the percentage of permanent cures drops to less than 10 per cent. Most cases come to the surgeon at a time when axillary glands are already involved. He says that we are curing 30 to 35 per cent of cancer of the breast cases.

Carcinoma of the breast in the young, during pregnancy, and the acute inflammatory type of carcinoma, all offer a very poor prognosis.

TREATMENT

Operable cases of carcinoma of the breast require the radical operation. This consists of removal of the entire breast and overlying skin, both pectoral muscles, and the axillary fat and lymph glands. The modern operation as devised by Halsted and by Meyer is the method of choice. This operation is done by cleaning out the axilla first, and removing the axillary contents, pectoral muscles and breast in one mass.

In some late cases a simple mastectomy is done as a palliative measure.

The modern radical breast operation is performed without much loss of blood, and without much shock. By opening the axilla first the blood vessels are secured early in the operation. Also, by this method we are less apt to milk lymph which contains cancer cells into the wound, or in aberrant directions through the lymphatics.

There is some evidence that postoperative irradiation is of value in carcinoma of the breast.

Trout and Peterson[12] of Roanoke, Va., received replies to a questionnaire sent to 149 surgeons and 199 radiologists; 89 per cent of the surgeons and 91 per cent of the radiologists believe that postoperative irradiation is beneficial as an adjunct to surgical treatment of carcinoma of the breast.

Preoperative Irradiation: There is some question as to the advisability of preoperative irradiation. Severe reactions sometimes occur and may occasionally favor metastases. Also, if operation is deferred a month or two to allow the full effect of

the irradiation to be exerted, there is additional time for metastases to occur.

Pancoast[13] says that he had a rather unhappy experience with a group of cases irradiated preoperatively. Most of them recurred rather rapidly even with postoperative treatment. He further states that he is uncertain about the whole procedure and is waiting for more evidence.

Pancoast thinks that postoperative irradiation should be given as it cannot do any harm, and may do good. He believes that the patient should be allowed to fully recover from the effects of the surgical procedure before receiving postoperative irradiation. A month or two after operation a thorough series of treatments is given if no involved glands were found in the axilla; if they were found a second series of treatments is given later. Cases with higher degrees of malignancy had best be given more than one series whether glands are present or not.

In the present state of our knowledge routine postoperative irradiation treatment should be given in cancer of the breast cases.

In properly selected inoperable and recurrent cases considerable comfort may be obtained by irradiation. This is, of course, merely palliative treatment.

Irradiation is in no sense a substitute for surgery. Early removal while still a local disease is the best that modern treatment has to offer. This, followed by routine postoperative irradiation, seems to offer the best results. Pancoast mentions the case of a woman who came to him for treatment of a small lump in the breast of six months' duration. She had refused to be operated on. The growth disappeared after six months' treatment. Over a year later multiple bone metastases were found. Operation at the proper time might have prevented the spread of the disease.

I do not believe the operation should be any less thorough in operable cases because we have irradiation to fall back upon.

While discussing Dr. Bevan's paper[14] which was read before the Section on Surgery of The American Medical Association on June 27, 1930, Dr. Jacob H. Vastine of Philadelphia stated that his five-year cures in cancer of the breast cases are 87 per cent. There were 55 per cent five-year cures in cases with microscopically proved axillary metastases. These patients were operated on radically and this was followed immediately by postoperative irradiation within three weeks after operation.

We cannot rely on statistics alone in forming our ideas as to the value of the methods used in treating carcinoma of the breast.

The statistics that are needed are those compiled from the best men covering a large number of cases treated by surgery alone, by preoperative or postoperative irradiation, and by both combined. One group of statistics should cover strictly operable cases, and there should be further modifications of groups to include cases with axillary gland involvement and possibly other features. Also, each pathologic or prognostic group of breast cancers should have its own statistical tables. This is an enormous undertaking, but until it is accomplished, there should be less controversy over the unknown.[13]

SUMMARY

1. Early diagnosis is the keynote to successful treatment.

2. Arrests of less than five years' duration have no statistical value.

3. It is possible to cure 75 to 80 per cent of cases if they are treated while the disease is localized to the breast; when the axillary glands are involved less than 10 per cent of the patients survive five years (Bevan).

4. The radical operation and postoperative irradiation are the best treatment for operable cases.

5. There is need for more uniform and comprehensive statistics.

[For References see p. 248.]

PRIMARY DUPLEX LIVER CARCINOMA*

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PRIMARY carcinoma is apparently quite a rare occurrence and of but slight practical importance. Clinically and grossly, the diagnosis cannot be made if there is also a carcinomatous involvement present in the stomach or some other organ in which primary malignancy is a more usual occurrence. Microscopically, however, it can always be made regardless of the presence of other malignancies, if the structure of the liver neoplasm shows the characteristic features of the hepatic tumor.

The case reported in this paper deserves notice on account of some unusual features both in the gross and microscopical appearance of the liver neoplasm.

CASE REPORT

S. G., male, sixty-four years of age, was admitted to the hospital on January 1, 1931 on the service of Dr. Henry Lerner, complaining of indefinite pains in the upper portion of the abdomen. These pains had been present since August 2, 1930, when he suddenly felt weak and faint and thought that he was going to die. At that time he had no dyspnea or pain but felt "as if all his strength was oozing out of his body." Subsequently he had vague dull pains in the upper portion of the right side of the abdomen. These pains had no relationship to his meals, sometimes travelled up to his right shoulder and finally became continuous and more intense. At no time was there any melena, vomiting, cough, precordial pain, or diarrhea. His appetite was good but he had lost 10 pounds during the month previous to admission. The family history and past personal history were entirely negative.

Physical examination revealed a well developed white male adult in the early sixties, appearing chronically ill. Scalp presented no lesions. Eyes reacted to light and accommodation, pupils were equal and regular. There was a slight icteric tinge to the sclerae. Nasal passages were normal. Teeth were somewhat carious; pharynx was clear. No palpable glands were present in the neck. Thyroid was not palpable and no abnormal pulsations were present.

Chest was emphysematous (barrel chest). There was equal expansion on both sides with somewhat increased resonance throughout. No râles were heard. Heart was not enlarged; impulses were distant but regular and no murmurs were heard. Blood pressure was 118/70; pulse 70 per minute; respirations 18 per minute; temperature 99°F. The abdomen presented tenderness over the right upper quadrant. The liver was palpable and its dullness extended downward to almost the level of the umbilicus. The liver edge was quite hard, tender and slightly irregular. No other palpable masses or points of tenderness were present in the abdomen. The Murphy signs were negative. There were bilateral inguinal herniae present. Rectal examination showed a small, moderately hard, but not tender prostate. The extremities presented slight edema about the ankles. The reflexes were normal. His weight was 126 pounds.

Laboratory reports were: Wassermann and Kahn tests were negative. Blood chemistry showed urea nitrogen 9.8; creatinin 1.4; glucose 62 mg. per 100 c.c. of blood. Van den Berg direct and indirect were positive. Sugar tolerance showed 77 mg. on the fasting stomach; 98 mg. one-half hour after the sugar was given; 139 mg. one and one-half hours later; and 118 mg. three hours later.

Urine examination showed 1.018 specific gravity; faint trace of albumin; no sugar; slight trace of bile; and microscopically there were a few white blood cells.

Hemoglobin 90 per cent; red blood cells 4,080,000; white blood cells 10,600 with polymorphonuclears 77 per cent; lymphocytes 20 per cent; monocytes 2 per cent; eosinophiles

* From the Koster Clinic Crown Heights Hospital.
Submitted for publication April 1, 1932.

1 per cent; bleeding time three and one-half minutes; coagulation time four minutes.

Fragility test was normal.

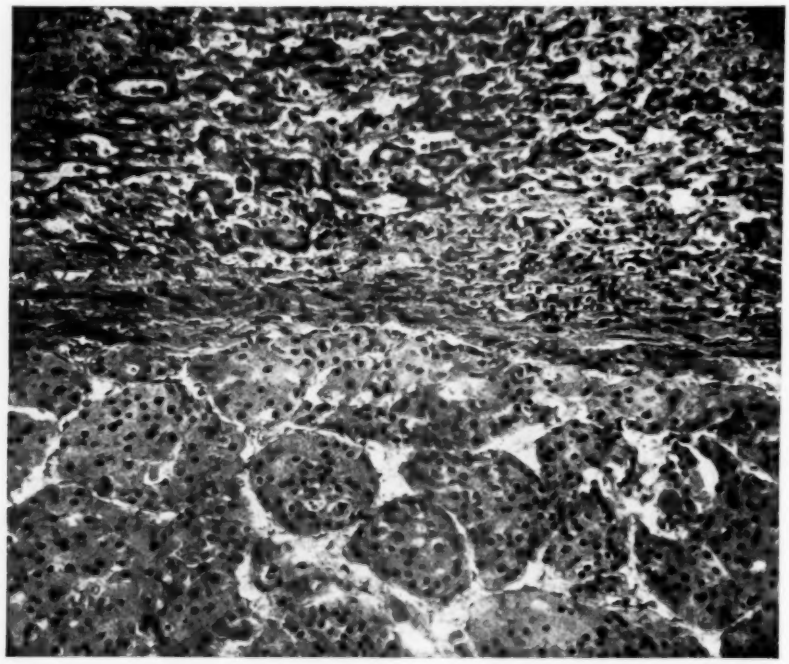

Fig. 1. Hepatocellular carcinoma tissue with wide blood spaces separated from adjacent tubular adenocarcinoma by a strand of fibrous tissue.

The blood counts were repeated three times and all were practically the same.

The gastric analysis was completely normal.

X-ray of the gastrointestinal tract revealed no abnormalities.

The medical service made a diagnosis of liver carcinoma secondary to some small focus in the gastrointestinal tract.

On February 10, 1931, the surgical division, concurring in the diagnosis of a liver carcinoma, and suggesting the possibility of its primary origin, advised a laparotomy for exploration.

On February 11, 1931, under spinal anesthesia an exploration was made. On opening the abdomen a moderate amount of ascites was found. The liver was markedly enlarged, hob-nailed and studded with white and brown nodules varying in size from a pin-head to a pea. A complete exploration of the entire abdominal viscera did not reveal any other focus. A wedge-shaped portion of the liver was excised for biopsy and the cut edges sutured together. The abdomen was closed in layers.

The day following the operation the patient suddenly went into shock but responded well to treatment. His condition remained satisfactory until February 15, 1931, when he died suddenly of pulmonary embolism.

A consent for wound inspection only was given. All the abdominal viscera were inspected minutely. No involvement of any organ was found with the exception of the liver. The heart showed a moderate amount of myocarditis with an embolus present in the pulmonary artery and with other smaller emboli in its branches in the lungs.

Pieces of the liver containing these white and yellowish-brown nodules were removed for histological examination.

The yellowish-brown nodules present on the portions of liver removed for study became green in color after formaldehyde fixation. Microscopically sections of these nodules showed a typical hepatocellular carcinoma. The cells were in the characteristic trabecular arrangement and the trabeculi were separated by the wide blood sinuses, lined with cells comparable to the Kupffer cells of the liver. The trabeculi consisted of cells very similar to liver cells and in some places were quite regular in size and shape. In these latter places the main difference between ordinary liver tissue and this tumor was the large size of the tumor trabeculi. In other places, however, conspicuous irregularities of the nuclei in both

size and shape could be seen. The regressive changes of the tumor tissue included fatty and hyaline degeneration of the cells. Extensive areas of necrosis were also present. The nodules of the tumor tissue were surrounded by fibrous connective tissue in which, occasionally, distended bile ducts were seen. The adjacent liver tissue quite frequently showed intracapillary invasion by tumor tissue which grew and pushed the adjacent tissue aside. The

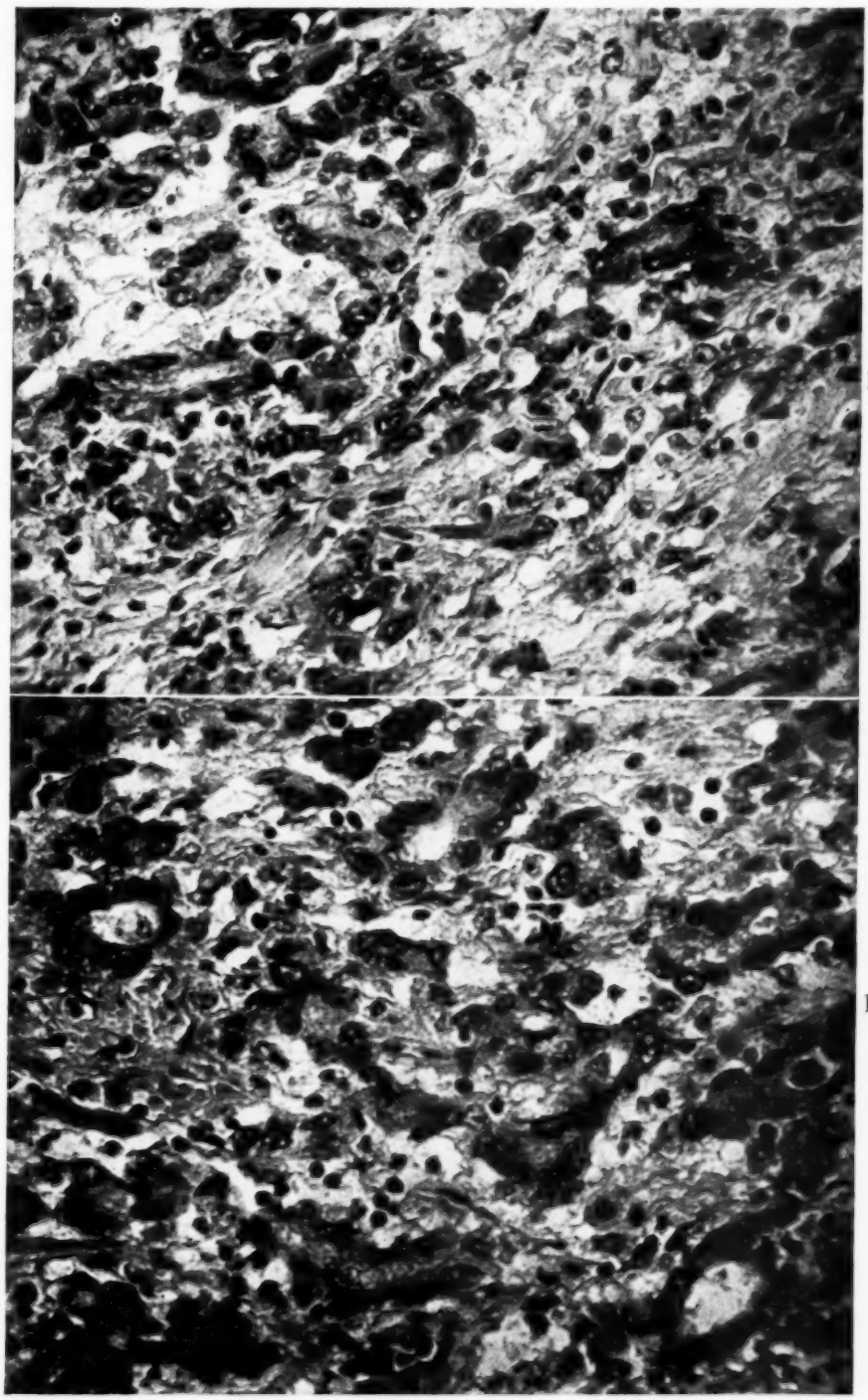

Fig. 2

Fig. 3

Fig. 2. Fibrotic area of tubular adenocarcinoma with mostly solid tumor cell groups and polymorphonuclears.
Fig. 3. Typical part of tubular adenocarcinoma.

latter was flattened out in concentric layers. Tumor tissue also invaded some of the larger veins forming tumor thrombi which very often appeared completely necrotized or mixed with ordinary thrombus material.

The multicentric origin of the tumor was clearly seen in areas directly not invaded by tumor tissue in which the liver cells showed striking evidence of anaplasia with gigantic and bizarrely formed nuclei. There was no

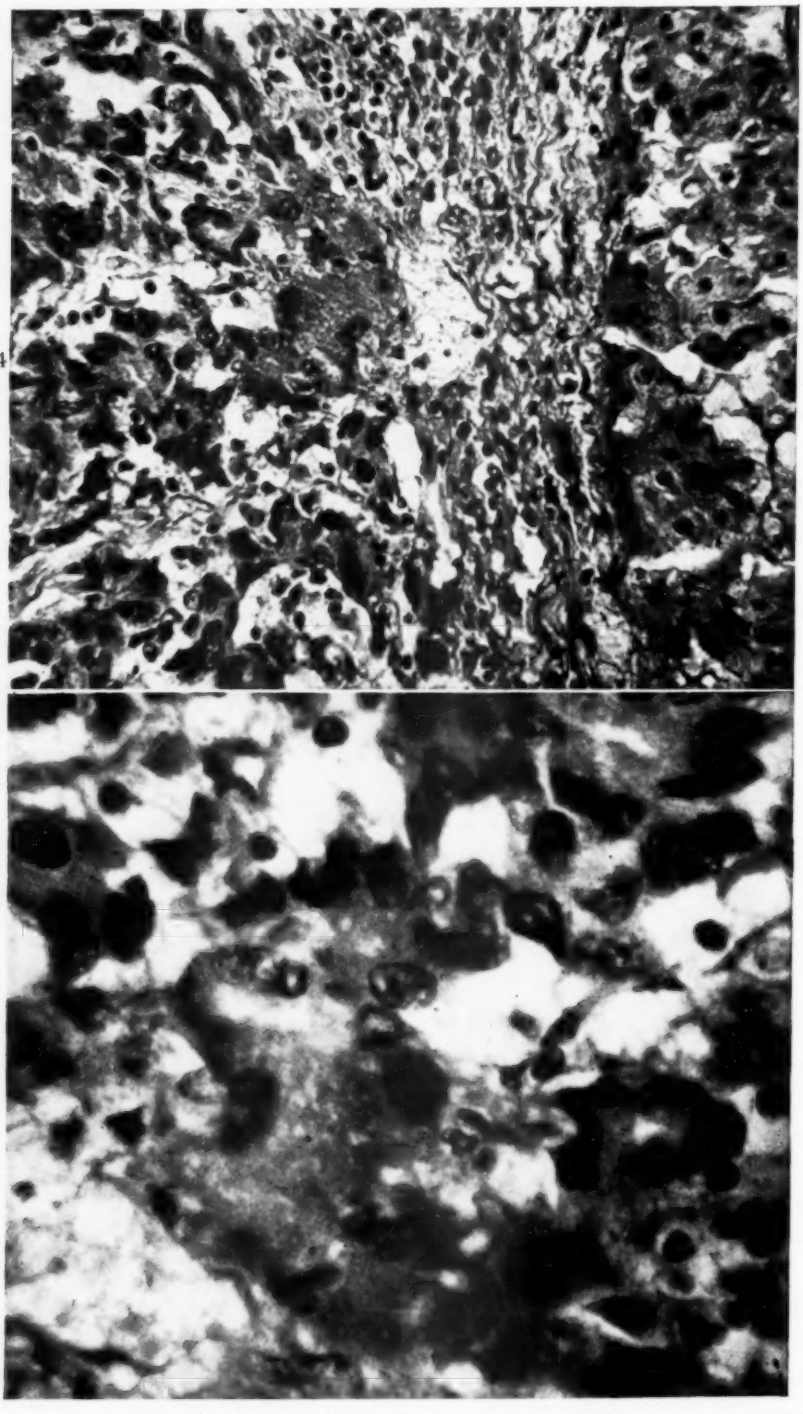

Fig. 4

Fig. 5

Fig. 4. Both tumor types separated by fibrous tissue. There are intermediary stages in adenocarcinomatous tissue with intracellular pigment.

Fig. 5. High power magnification of previous field (Fig. 4).

doubt that these peculiar cells were real liver cells and not metastases of the tumor tissue. Architecturally they fitted in like the regular pattern of the trabecular liver structure. Moreover, they were earmarked as liver cells because they contained the same yellowish-brown pigment which was present in the adjacent perfectly normal liver cells.

The stroma of the liver showed a quite noticeable increase of connective tissue particularly in the periportal fields similar to that seen in Laennec's cirrhosis.

The whitish nodules were of an altogether different structure. There was no trabecular structure visible nor any blood sinuses like those already described. The tumor tissue consisted of a fairly dense tubular parenchyma separated by more or less abundant fibrillar connective tissue with quite a good deal of lymphocytic and leucocytic infiltration. The tubular structures were quite regular in places and simulated the well known pseudo-bile ducts found in liver cirrhosis. The nuclei were round or oval in shape and fairly regular in places. In the main, however, they were very polymorphous and occasionally grouped together in giant cell formation. The tubular character was not uniformly distinct; in some places the lumen was absent, and thin arborescent trabeculi of two cell widths replaced the tubular structures.

The tubular type of neoplasm and the typical hepatocellular type were very often very close together. Sometimes a narrow zone consisting of some surviving liver tissue separated the two neoplastic tissues. In such places encroachment from both could be seen. Quite frequently only a thin wall of fibrous connective tissue separated the two different neoplastic tissues.

While the appearance of the tubular tumor tissue was distinct from the ordinary hepatocellular tumor tissue, there were places in which the change could be observed which made the two different types of tumor cells somewhat comparable. The cell body of most of the cells in the tubular type of tissue was small and the scanty cytoplasm stained a pale bluish-purple color. There were places however, where the cytoplasm took on a more pinkish color similar to that of the hepatocellular tumor cells. Moreover in places there was a peculiar enlargement of the cell body together with a loss of the tubular lumen. Thus large, almost syncytial cell groups were formed. The cytoplasm of these peculiar structures which were only found far in between the tissues contained some of the yellowish pigment which was present in most of the surviving liver cells.

The description of the two different types of neoplastic tissue indicated that we were dealing with a duplex process of malignancy in one organ. The product of one process was a typical hepatocellular carcinoma; that of the other was a tubular adenocarcinoma which is much more common and, as a rule, interpreted as the product of bile duct epithelium and classified as cholangocellular carcinoma.

It appears, however, that in this case the tubular adenocarcinoma did not take its origin from the bile duct epithelium but represented the product of liver cells. The presence of pigment in some of the tumor cells and the occasionally observed transitional forms between the two neoplastic cell types were strongly suggestive of such histogenesis.

It seems probable as pointed out previously by Goldzieher[1] that there is an intermediary stage between such tubular neoplastic tissue and the liver cells. This stage is represented by the so-called pseudo-bile duct which develops in cirrhotic processes of the liver from liver cells and may give rise to neoplastic tissue morphologically identical with cholangocellular tumors. Yet a reversion to the original liver cell type remains possible. The fact that some of the pseudo-bile ducts retain the yellow pigment explains how such pigment can be found in tumor tissue of such origin.

The interesting feature of this case is the indiscriminate mixture of the two morphologically different neoplastic types in one liver. The only other case on record to our knowledge is the one reported by Goldzieher[2] in 1928. Yet in his case the bulk of the tumor tissue was purely hepatocellular and only one nodule was of the tubular adenocarcinomatous type. It is noteworthy that his one nodule was quite different in its gross appearance from the other tumor nodules. It was whitish in color and firmer than the other nodules. This coincides with our own observations.

[1] Goldzieher, M. A., and Von Bokay. *Virchows Arch. f. path. Anat. u. Physiol.*, 203: 75, 1911.

[2] Goldzieher, M. A. *Virchows Arch.* 267: 326, 1928.

CALCIUM TREATMENT OF PAIN IN CANCER*

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THE pain associated with cancer is one of the most disturbing and annoying symptoms which the physician is called upon to treat. Its terrifying constancy, and hopelessness of relief is well expressed in the following little poem from "The Blind Pursuer" by Ada Alden.

Through the faint day, and even in his dreams,
The pain pursues him edged and merciless,
Or just a blunt distress
All night the tortured, crying mysteries—
Bones, muscles, nerves, whose names he does not know—
Are thrusting out their masked identities;
Battering and breaking down the fast-shut door,
Beyond whose silence swings the radiant sign
That pain shall be no more.

How vividly do these few lines express the constant distress of a cancer patient! Any drug or method which will relieve this distress and pain will be of inestimable benefit.

It consequently has been extremely gratifying to the writer to note the effective and surprising results which, in certain cases, calcium has had in reducing and, in some instances, completely alleviating the pain of those suffering with inoperable cancer. The patient's existence becomes more bearable, the mental state improves, and the fight against the disease is once more resumed. The growth of the cancer itself is frequently retarded and may be totally controlled. Even though these latter results are obtained only in a restricted number of cases, calcium still merits a high place in the therapy of cancer if it only relieves pain and renders the use of narcotics unnecessary. This, in itself, if true, is a most important advance in the treatment of cancer. If, by using calcium, narcotics can be discontinued, the evil effect of their use as expressed in terms of lassitude, lack of appetite, retarded activities of the tissues of the body and generalized depression are avoided. The patient becomes active and has a healthy appearance, with high color, a good appetite; and a feeling of well-being replaces the usual depressed attitude. I have noted this beneficial reaction almost constantly and have seen it persist up to the death of the patient.

In previous communications,[1] the writer has discussed the effect of calcium in malignant tumors, and further observation and study gives conclusive evidence of the beneficial effect of this therapy. Especially is calcium to be relied upon for the relief or reduction of pain. By its use the last days of a cancer patient are made more comfortable.

The patients whose histories are cited and who were treated with calcium, all suffered from incurable cancer, and the pain which they had, and which is almost universally associated with this disease, was lessened or entirely relieved. This relief with but a few exceptions, which will be noted, was the result of the administration of calcium. At first calcium was given in the form of the chloride and administered intravenously; later the gluconate was given intravenously for those cases in

[1] Review of the medical treatment of cancer. *Western Med. Times*, Feb. 1928.

Treatment of malignancies. *West Virginia M. J.*, 23: 241, May, 1927.

Non-surgical treatment of cancer, *Trans. Am. Therapeutic Soc.*, p. 73, May 14–16, 1927.

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* Submitted for publication April 13, 1932.

which a rapid reaction was desired; intramuscularly if immediate results were not so urgent.

In addition to the administration of calcium, intravenously and intramuscularly (the action of which is more or less evanescent), it was also necessary to provide a constant source of calcium supply. This was best accomplished by giving large doses of calcium by mouth so that on absorption from the intestinal tract, the body fluids constantly were over saturated; to induce this condition the patient was given at least 2.0 gm. of calcium gluconate orally, three times a day. In order to further stimulate the activity of the calcium, cod-liver, alone, ½ ounce three times a day, or codliver oil with viosterol was also supplied the patient, the dose being one dram, three times a day. A peculiar antagonism to cod-liver oil was present in several of our patients who were taking calcium. A few days after beginning, per os, the ingestion of 1 ounce of cod-liver oil (Waterbury's) three times a day, they complained of being sick, and stated that they were "made very sick by the oil, so that they developed a strong aversion to it." Those who were not taking the calcium did not notice such an aversion.

In connection with the administration of cod-liver oil, it is well to recall that the only other foods in which vitamin D is present, in amounts sufficient to be of therapeutic value, are egg yolk and cream. These may be placed in quantity in the diet. To further mobilize the calcium in the system, parathyroid extract was given to a few patients but, for reasons which were considered significant, was later discontinued.

At first, because of the large doses of calcium, it was expected that disagreeable effects of hypercalcemia might result; no pernicious reactions were noted (though the blood calcium in some cases temporarily mounted to 20 mg. per 100 c.c.). Minor symptoms, as loss of appetite or a slight malaise, did occur. When these developed the calcium which had been given per os was immediately discontinued.

In cancer therapy it is also absolutely necessary that the patient's appetite be preserved in order that his weight and general well-being be maintained at a high level. In my experience, increase in weight in a cancer patient is usually a sign of good portent, while a loss of weight seems to be an indication of increased activity of the neoplasm, or at least a loss of resistance by the patient. In every case it is of evil significance.

Without discussing the manner in which calcium influences the pain which is usually associated with the terminal stages of a cancer, I shall report the histories of several patients suffering from cancer, in whom pain was an insistent factor, and in whom there was a definite relationship between the administration of calcium and the cessation of the pain. In some of these cases it will be noted that the administration of calcium was temporarily discontinued, with return of the pain, which promptly disappeared again on the resumption of the calcium treatment.

Most of the reports date back two or three years. Our recent cancer patients have little or no pain; they are all treated with calcium with entire relief except in those who are in the terminal stage of cancer and in whom the original growth or metastases produce pressure on terminal nerve filaments, thus causing pain. Pressure pain is not easy to relieve by calcium, though there is a slight benefit from its use. Pain due to the action of radium may have no relief.

In order to conserve time, I have abbreviated the case reports so that only the most salient points in each are mentioned.

Case 1. *Multiple metastases from mammary carcinoma.* Mrs. M. M., aged thirty-eight. Dr. H. Patient had multiple metastases in the ribs, skull, pelvic girdle, vertebrae and femur. These caused severe pain and she noticed that when the pain was in the leg there seemed to be a muscular weakness also. Pain was present in the ribs and under the shoulder. This patient was relieved by the injection of calcium; one injection only was required to give entire

relief. This particular reaction was rather unusual in that the pain which was relieved was due to metastases in the bone. However, none of the metastatic growths in this case was large enough to have produced pressure on the cortex. (Calcium action upon the cancer tissues would not relieve the pain due to such pressure.) In this instance the pain was probably due to disturbances in the metabolism of the bone itself, in which type of case relief by calcium administration occurs almost uniformly.

Case II. *Metastatic carcinoma of mesenteric glands after operation for neoplasm of cecum.* Mr. P. K., aged sixty-one. The patient reported that in every instance on the day following the administration of calcium chloride intravenously he would experience some pain the next morning (a soreness as he described it) rather than an acute pain. The soreness or the pain in the abdomen (where the neoplasm was located) would be absent for four or five days after this reaction—pain due to the calcium administration, and then would again return.

This temporary increase of pain in the neoplasm after the administration of calcium has been noted in several patients, particularly in those in whom the calcium treatment is forced.

Case III. *Metastatic and recurrent carcinoma of breast.* Mrs. D. L., aged twenty-seven. At eighteen years this patient noticed a lump in the breast the size of a cherry. For six years it did not appear to grow, but was tender at times. In 1928 the nodule was removed by Dr. W. In the summer of 1929 the lump reappeared at the same place. Dr. D. did a local excision. After microscopic examination he advised amputation, which was done in August, 1929. In October, 1929 a lump appeared in the supraclavicular region which was removed under local anesthesia by Dr. E. In December, 1929 a series of two *x*-ray treatments (5 min. each) were given. In January, 1930 there was no evidence of skin recurrence, no palpable glands in either axilla or neck. Radium treatments were instituted at Baltimore between January 13, 1930 and January 27, 1930, over the right supraclavicular region and the right axilla. On January 13 *x*-ray exposure of a full dosage over the right axillary fold was given. On February 27 a mass was found immediately to the right of the upper portion of the sternum. This received 9 gram hours of radium at a distance of 2 inches. On April 12, another mass was found on the right lower chest and was given an exposure of 2 gram hours at one inch distance. Neuralgic pains developed in the right shoulder and she was given further radium treatments.

On May 19, 1931 the patient entered St. Joseph's Hospital, complaining of severe pain in the right shoulder and arm radiating to the tips of the fingers, and to the scapula. The pain was sharp, stinging and pricking, it came and went quickly, was rather severe; it was worse about one hour after she received her radium treatments. She had been taking about 2 to 4 grains of morphine daily. Patient was given 1 ampoule of calcium gluconate on May 19, 1931, May 20, 1931 and on May 21, 1931. On May 21, 1931 she stated that the pain in the arm was better and the pain in the chest was better, but not entirely relieved. An ice cap to the chest relieved her and she had no pain. On May 24, 1931 she had no calcium and the pain returned. On May 25, 1931 it was noted that the metastatic nodules toward the right shoulder seemed smaller. On May 26, 1931 at 4:30 P.M. she complained of pain in the chest. Calcium gluconate was given and it was noted at 8:00 P.M. the pain was relieved. On May 27, 1931 the pains were relieved. On May 28, 1931 it was noted that the patient had had no pain for the past forty-eight hours, felt improved. Patient returned home. The improvement did not continue. The metastatic nodules increased in size, the arm became swollen and very painful. This pain was not relieved by calcium, although it could be controlled by 1 grain of codeine twice a day. Patient died in September, 1931. In this patient it is to be noted that the pain was fairly well controlled until the pressure on the axillary nerves caused the radiating pains in the arms. These pressure pains were not controlled by calcium.

Case IV. *Carcinoma of cecum and terminal ileum.* Mrs. M. S., aged fifty-five, presented an inoperable carcinoma of the cecum and terminal ileum. The patient had been taking large quantities of morphine, but after being given calcium gluconate, only a few doses of 1 dram of paregoric were required to relieve the pain. No morphine was administered. The patient was first treated by calcium on October 21, 1929 and was free from pain on November 14, 1929, or in twenty-three days, and from that time was almost entirely free of pain till her death on January 16, 1930.

Case v. *Adenocarcinoma of cervix uteri. Multiple metastases.* Mrs. M. H., aged forty. Cancer of the cervix uteri, metastases to the chest wall and metastatic bone lesions involved the ribs and sacrum. Recurring pains due to the disease were relieved in two days by calcium gluconate, 1 ampoule, 1 gm. every second day, given intramuscularly. She had a blood calcium of 17 mg. at this time. Patient did not continue the calcium treatments. Went to another hospital, had deep therapy, and died in four months.

Case vi. *Carcinoma of cervix uteri.* Mrs. E. S., aged thirty-six. The pains which were severe and continuous and were felt in the lower abdomen, the pelvis and the back, were relieved with 3 ampoules of calcium gluconate (one daily for three days). The patient lived five days after entering the hospital. Relief of pain occurred within a few hours after the first injection of calcium gluconate. This patient had been getting as high as 2 grains of morphine daily before entrance into the hospital. After the calcium was given the morphine was stopped.

Case vii. *Adenocarcinoma of esophagus.* Mrs. G. F., aged forty-five. The pain was controlled up to the time of death by calcium gluconate administered intramuscularly. When pain would recur the relief was immediate on the administration of calcium. This patient was in the hospital six weeks. A gastrostomy was done and death was due to bronchopneumonia. Autopsy showed an adenocarcinoma of the middle third of the esophagus and carcinomatous infiltration of the neck.

Case viii. *Adenocarcinoma of rectum.* Mrs. M. V., aged sixty-two. The patient was in great and constant aching pain, which at times was beating. The pain was localized around the anus and in the pelvis. On July 16, 1930, one ampoule of calcium gluconate was given intramuscularly, and in forty-eight hours another ampoule was given. On every third day an ampoule of calcium gluconate was given. Only once, on July 23, 1930, was it necessary to administer a narcotic (pantopon). The discomfort from which the patient suffered rapidly disappeared until on September 1, 1930 she acknowledged that there "was no more pain." In this case, with minimal calcium treatment, the pain was entirely relieved in forty-six days and the patient was pain-free for over three months, after which the treatment was neglected and the pain returned.

Case ix. *Adenocarcinoma of cervix uteri.* Mrs. M. M., aged fifty-one. The progress notes on this patient state that the pain was relieved by the administration of calcium gluconate, though the time interval is not recorded. It is stated, however, that when the administration was discontinued the pain returned, again to be controlled after the calcium gluconate had been given daily for three days. On September 10, 1930, the calcium was discontinued because of nausea and vomiting, and the patient remained free from pain until the time of her death on October 2, 1930. In this case there was apparently a continued effect of the calcium, even after its administration had been stopped. This extension of the effect of calcium long beyond the period of its discontinuance has been noticed in many patients.

Case x. *Adenocarcinoma of breast with substernal metastases.* Mrs. M. L., aged thirty-six. Dr. R. W. L. The patient complained of pain under the sternum radiating to both sides which had been previously controlled by the administration of three ¼ grain tablets of morphine every twenty-four hours. It was found that the morphine could be discontinued after three injections of calcium gluconate over a period of four days, and the patient remained entirely free from pain, with calcium gluconate injections every other day. It was impossible to follow this case further because of the fact that the patient left the city. It was reported she had recently died.

Case xi. *Carcinoma of sigmoid.* Mr. J. D. From August 6, 1929 until Aug. 15, 1929 the patient had had severe pain which was controlled by the administration of morphine and pantopon. On August 13, calcium gluconate was administered intramuscularly. On August 15 calcium chloride gm. 1.0 was given intravenously and on August 16 and the 20 calcium gluconate was again given intramuscularly. On August 28, 1929 the patient was completely free of pain. Calcium gluconate was given every fourth day. On October 30, 1929 pain developed due to urinary retention and was not controlled by the administration of calcium gluconate. On November 26, 1929 it was necessary to administer pantopon for the control of pain, the result of a severe cystitis and retention of urine. The patient died on December 31, 1929.

In practically all of the cases cited, the patients had been previously treated with

morphine to control the pain, or else had suffered pain which had not been relieved. In the former group, calcium treatment after a few days replaced the morphine, and the patient was apparently more comfortable than under the administration of narcotics, while in the latter group pain was uniformly controlled. Calcium not only relieved the pain, but produced a buoyant feeling in the patient, resulting in the resumption, in many cases, of individual activities. This attribute, alone, makes *calcium most valuable in the therapy of cancer.*

Pain due to bone metastases was not as certainly and uniformly relieved by calcium treatment as was that of cancer confined to other tissues. A reason for this may be that pain production in bone metastases is in a large measure due to the pressure exerted on the cortex of the bone and the periosteum by the constantly enlarging tumor. This pressure is not relieved by calcium treatment.

Reduction in the volume of the tumor by the action of the calcium on the cells, and lessening of the irritative perineoplastic and intraneoplastic tissue juices by the calcium is of only temporary benefit and lasts only until the size and magnitude of the tumor outbalance the beneficial changes produced by the calcium.

SUMMARY

Every patient affected with cancer has pain at some period of the disease. This can be controlled by narcotics in constantly increasing dosage. Calcium may be substituted for narcotics. It either entirely controls the pain or greatly reduces it. Calcium is not harmful and seems to have a curative action on the cancer tissue. It acts by decreasing cell permeability, lessening edema, reducing glycolysis and decreasing the sensitivity both of nerves and nerve centers. In all my cases it has had a beneficial influence.

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*Continued from page 193.

VESICOVAGINAL FISTULAS TREATED BY ELECTROCOAGULATION*

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CASE I. In October, 1922, I examined a married woman thirty-five years of age who gave a history of an operation for the removal of the uterus, for fibroids, four months previously.

Ten days following this operation a watery discharge began to drain from the abdominal wound. This, on examination, was found to be urine. Shortly after this urine began to discharge through the vagina. The abdominal fistula closed following applications of nitrate of silver but the urine continued to discharge through the vagina. The patient was constantly wet with urine and had great difficulty in taking care of herself. She slept on a bedpan to keep from saturating the bed.

Combined cystoscopic and vaginal examination revealed a fistula in the right bladder base above the right meatus. A No. 6 ureteral catheter could be passed through this opening. The irrigating fluid drained out quite rapidly.

I had previously employed electrocoagulation in the treatment of postoperative fistulas following both perineal and suprapubic operations in the male and considered the advisability of using this conservative method here. The surgical attack in this case would have been difficult as the opening was located high up to the side of the cervical stump.

Electrocoagulation was carried out both from the bladder and vaginal side, the current was applied until the surrounding tissue showed a blanched-out appearance.

During the first few days following the electrocoagulation there was very little drainage of urine through the vagina, but soon the condition was as bad as before for a period of about two weeks. The patient returned for examination in November, 1922, and reported considerable improvement, at this time voiding several ounces. Electrocoagulation was again carried out, with a Bugbee flexible electrode from the bladder side, and a stiff electrode on the vaginal side, employing for exposure a lighted vaginal speculum. The patient returned for examination on December 12, and reported that no urine had leaked for about two weeks.

I have not seen the patient since but have learned through the surgeon who performed the hysterectomy that there has been no return of the fistula and that the bladder function is normal.

CASE II. Electrocoagulation was used again on a woman forty years of age, suffering from two vesicovaginal fistulas following the removal of a large uterine fibroid.

The surgeon stated that he had encountered considerable difficulty in dissecting the bladder from the tumor.

Urinary leakage developed shortly after the operation. It was necessary for the patient to have a receptacle for urine in bed and to wear pads during the day.

Cystoscopic examination, April 17, 1929, showed an irregular sacculation 2 cm. above the trigone. It was impossible satisfactorily to distend the bladder with fluid for careful inspection. Upon filling the bladder with methylene blue solution and inspecting the vagina two fistulous openings were demonstrated well up in the lateral walls. The opening on the right emitted the blue fluid quite rapidly.

Electrocoagulation was recommended as a trial to this patient and was carried out at intervals of from ten days to three weeks, both through the cystoscope and from the vaginal side. This case proved more stubborn and it required six applications, over a period of three months, to effect a closure.

An examination on October 21, 1929, showed firmly healed scars and the bladder capacity and function were normal.

A review of the literature shows only one report upon this method of treatment of vesicovaginal fistula, made by Dr. Karl

* Submitted for publication September 16, 1931.

Hellmuth,[1] from the University Women's Clinic, Wurzburg. He quotes Dr. B. Ottow[2] who, in 1927, reported the cure of a vesicovaginal fistula by electrocoagulation; and gives a report of one patient with a vesicovaginal fistula following hysterectomy. One application of the current caused the fistula to heal. The patient was examined one year afterwards and found dry.

Hellmuth placed a retention catheter in the urethra for ten days and applied the current only from the bladder side. He also states that this conservative method is applicable only to small fistulas without dense scar tissue.

In conclusion I wish to emphasize that surgical repair of vesicovaginal fistulas is frequently not free from failure and difficulties and that electrocoagulation may be tried in closing fistulas of small caliber.

DISCUSSION

Dr. Francis L. Anton: Dr. Peterson's report of his treatment of vesico-vaginal fistulas by electrocoagulation and of his successful closure of these fistulas is a very valuable contribution to the treatment of this very troublesome condition. It is especially welcome to find such a simple procedure have such splendid results, especially because it is most applicable to small fistulas as it is these small fistulas that give the surgeon the greatest trouble and chagrin. It is certainly a miserable experience to find, after having carefully dissected out a very small fistulous tract and repaired it in the orthodox manner, by two or three layers of sutures, that the whole or a greater part of the suture breaks down and the patient returns with a condition much worse than before the operation; whereas, a large fistula presents frequently much less difficulty because one necessarily does a more extensive dissection, and in that way, we generally reach out beyond all scar tissue to tissues that have a more normal circulation. When these tissues are brought into contact, healing is more certain.

Dr. James F. Percy: As reported by the author neither of his patients' fistulas involved a ureteral orifice. When this occurs nothing but surgery will repair the condition so as to preserve the function of the involved ureter.

The chief factor behind nearly all of these small fistulas is redundant mucous membrane protruding from within the bladder. Destroying this membrane by surgical diathermy as described by Dr. Peterson, or with the actual cautery, frequently gives most gratifying results as has been reported.

[1] Hellmuth, K. Heilung kleiner Blasenfisteln mittels intravesikaler Electro-koagulation. *Deutsche med. Wchnschr.*, 1001–1002, 1929.

[2] Ottow, B. Ueber konservative Therapie kleiner Blasenfisteln mittels Elektrokoagulation. *Zentralbl. f. Gynäk:* 51: 347–350, 1927.

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* Continued from p. 236.

VAGINAL URETEROLITHOTOMY*

H. DAWSON FURNISS, M.D., F.A.C.S.

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AT times extraperitoneal abdominal ureterolithotomy for stone situated in the lower or juxtavesical portion of the ureter is most difficult, especially in fat women with deep pelves. In some cases it is necessary to divide the round ligament, the broad ligament, and the uterine artery to gain access to the stone. Then there is the problem of infection from drainage, and the possibility of an incisional hernia.

Two years ago in Vienna I saw Weibel do two vaginal hysterectomies for carcinoma of the cervix according to the Schauta technique and was impressed with the ease with which he could free the lower ureter. Stoeckel† described this operation and demonstrated the facility with which the ureter could be exposed.

In looking over the literature I find that vaginal ureterolithotomy has been done relatively infrequently. Most operators have cut down upon the stone after locating it by vaginal palpation, and in only a few instances has there been any methodical procedure of exposing the ureter.

Lower reported 6 cases; Garceau 2. Most of the others have referred to single experiences. The fear of a ureterovaginal sinus has deterred many from attempting this procedure; but from the experience of those who have reported cases, this has not seemed to be a troublesome factor.

Early this year there came under my care a patient with a stone in the lower end of the right ureter that seemed especially suitable for removal. This was done with such satisfactory results that I took up the problem of determining which cases were suitable for the vaginal operation, and of developing a technique.

† *Zntralbl. f. Gynaek.*, Jan. 3, 1931.

Only those stones that could not be made to pass, displaced upwards or be removed by some conservative technique,

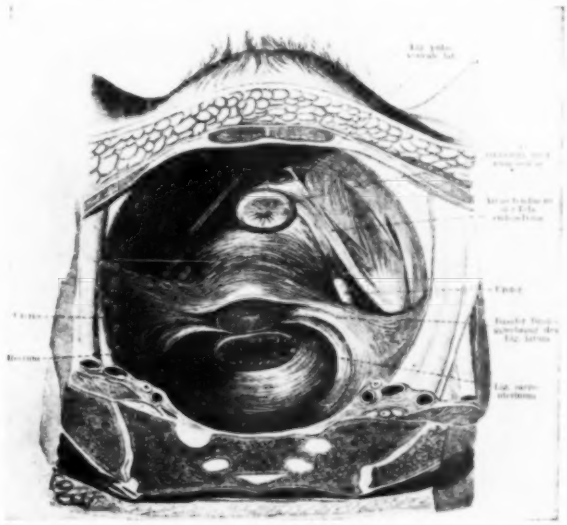

FIG. 1. Thickened portions of urogenital fascia around vagina, uterus and rectum. (After J. Tandler in Stoeckel-Veit, Handb. d. Gynaek.)

were considered operable. After work upon the cadaver it was found that stones in the juxtavesical portion of the ureter anterior to the uterine artery (the lower 1¼ inches of the ureter) would be suitable for vaginal removal; the portion of the ureter on the kidney side of the uterine artery would be much more difficult to expose. Those in the transvesical portion, not suitable for transvesical operation, might also be considered suitable. If the stone can be palpated, its relation to the uterus at the cervico-uterine junction should be noted, for it is at this point that the ureter passes under the uterine artery. If the uterus is anteverted the stone will be farther forward in the pelvis than when the uterus lies backwards. (See Fig. 4.) The kidney must not be

* Read before the Southern Surgical Association, December 9, 1931.

destroyed, and its function should be capable of improvement after the removal of the stone.

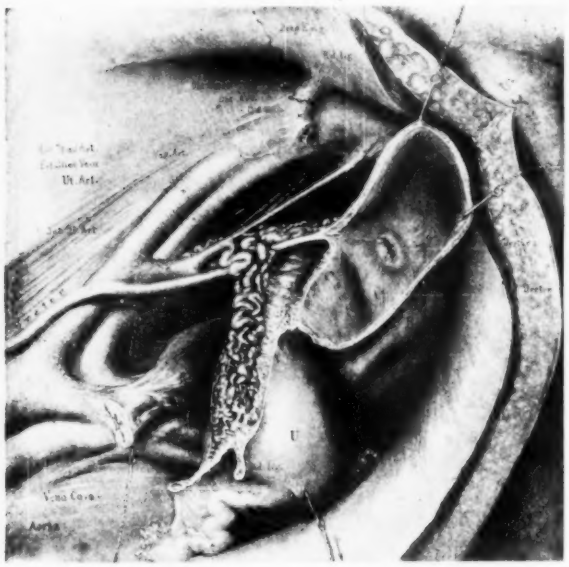

Fig. 2. Relation of ureter to uterine vessels as seen from above. (From Kelly.[20])

In women the *x*-ray does not always give the correct relation of a stone to the vesical end of the ureter, as the ureter may be displaced by malposition of the uterus, cystocele, and prolapse, as well as the presence of new growths and inflammatory conditions.

However, it is suggested that some standard technique be used in the location of the stones; I would suggest a 25 inch target-to-film distance and that with the patient in the dorsal position, the central ray be perpendicular to a spot midway between the superior border of the symphysis and the navel. I have had an opportunity to make some *x*-ray pictures on the cadaver in which the foregoing technique was used. The cadaver was an adult female with an intact pelvic floor. The markers were pins on which a drop of solder had been fused. The heads of the pins nearest the symphysis are at the entrance of the ureter into the bladder wall, and the heads of those cephalad mark the ureter where it passes beneath the uterine artery. The first picture is of the uterus in anteversion and the second with the uterus retroverted. Of course I realize the inclination of the pelvis to the table will cause a variation in the shadow on the film. However, with this technique, the probable location of the stone can be determined in persons without malpositions of the uterus or of the vaginal wall. In a woman with uterus of normal size and position and an intact pelvic floor, the shadow of a calculus at the uretero-

Fig. 3. Portion of ureter anterior to uterine vessels. This is the portion from which stones are best removed per vaginam. (After J. Tandler in Stoeckel-Veit, Handb. d. Gynaek.)

vesical junction should lie approximately 2.6 cm. above the shadow of the symphysis, and the shadow of a stone in the ureter as it

Fig. 4. Heads of pins are used as markers. Lower two are placed at uterovesical junction. Upper two are where ureter passes under uterine artery. Uterus is in anteversion. Film-target distance is 25 inches. Central ray strikes a point in midline, midway between symphysis and umbilicus.

passes beneath the uterine artery should be 4.8 cm. above the symphysis shadow; with the uterus retroverted, 1.2 cm. caudad to this.

In most instances the position of the stone in the ureter can be better located with a catheter, but occasionally one is unable to make a catheter enter the ureter and in a few the catheter will pass the stone without resistance. Intravenous pyelography is also of great value.

The anatomy of the pelvic ureter is shown in Figures 1 and 2.

The portion of the broad ligament where the ureter passes beneath the uterine artery is described as Schauta's *Schlitt*. In approaching the ureter through a vaginal incision it must be remembered that the ureter will be found below and to the outer side of the uterine artery.

OPERATION

The lithotomy position is used. If the vagina is small, or the uterus cannot be drawn well downwards, sufficient room can be obtained by making a Schuchardt incision in either or both vaginal sulci.

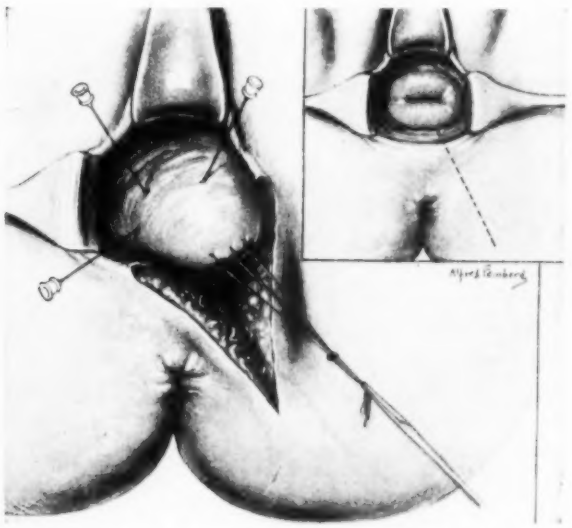

Fig. 5. Dotted line in insert outlines Schuchardt incision. Needles represent location in which adrenalin solution to produce ischemia is injected. Vesico-uterine and parametrial tissues on involved side are also infiltrated.

This incision begins high in the vagina and extends through the transversus perinei and the levator ani muscles in a backward and outward direction almost to the tuberosity of the ischium. It is well not to bring it too close to the sphincter ani for fear of disturbing its innervation with consequent partial incontinence. Infiltrating the tissues to be incised with adrenalin chloride solution (9 drops of 1:1000 solution to each 100 c.c. of saline) will prevent troublesome oozing. Vessels that bleed are clamped and ligated.

Three stout sutures are passed through the two lips of the cervix, tied, and the long ends clamped together to act as a tractor. The anterior wall of the vagina, the vesico-uterine connective tissue and that of the parametrium on the side of the stone are infiltrated with the same adrenalin solution, from 50 to 75 c.c. being used for this purpose. The ischemia so induced makes dissection easier, and bleeding is almost nil. If the vessels that are seen to bleed are promptly ligated there is little fear of subsequent hemorrhage.

An incision is made over the anterior vaginal wall in a transverse direction from slightly to the side of the cervix opposite the stone, over its body, to well behind the uterine artery on the side of the stone. By dissection in the areolar tissue that lies between the bladder and the cervix, the bladder is separated in the median line as high as the vesicouterine peritoneum. On either side will be seen fibers running in an anteroposterior direction attached below to the cervix, forming the bladder pillars. These are now separated from the cervix on the side of the stone with a few snips of the scissors. A few small vessels here need ligation. By scissor dissection along the lateral border of the cervix the uterine artery will be brought into view. Traction downwards and to the opposite side of the

Fig. 6.

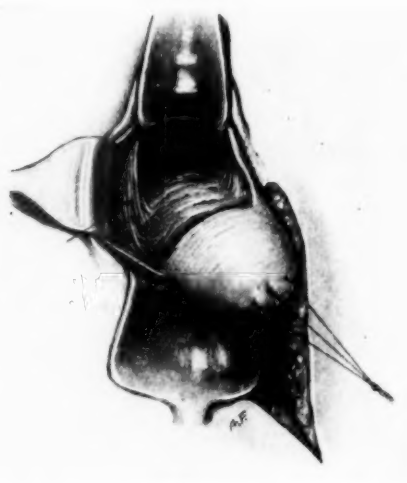

Fig. 7.

Fig. 6. Uterus drawn downward and to side opposite that of stone. Outline of mucosal incision.
Fig. 7. Bladder has been freed in midline from anterior surface of cervix. On either side are seen pillars of bladder.

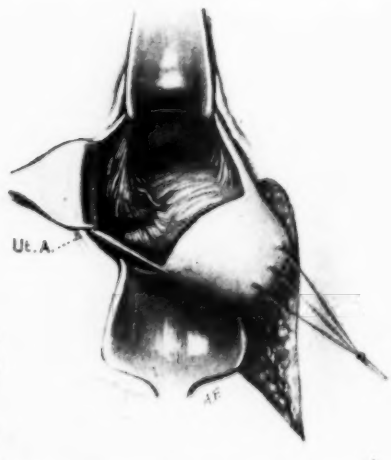

Fig. 8.

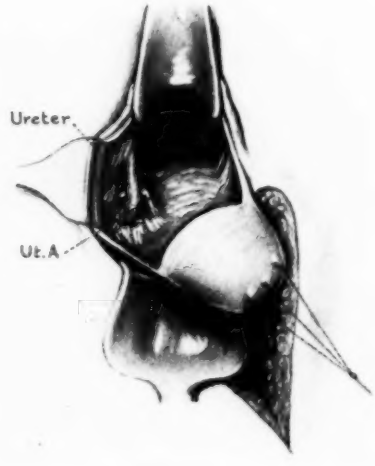

Fig. 9.

Fig. 8. Freeing pillars and slight dissection along lateral margin of cervix brings into view uterine artery. When fibers to cervix are freed, there may be some bleeding, which should be controlled by suture ligation.
Fig. 9. Following uterine artery will bring one to ureter. Traction downward on cervix (and uterine artery) will cause ureter to be kinked and to present as a knee. From this point forward ureter is easily freed to bladder. Ureter is usually found a bit farther outwards than appears in drawing.

cervix will cause the ureter to descend and to be kinked by the uterine artery; following the uterine artery will invariably lead to the ureter, which will appear as a whitish shining structure. It must be remembered that the ureter is in the parametrium and not close to the cervix. Fortunately in all instances of stone large enough to necessitate removal, the ureter is so dilated and thickened as to make its recognition easier. After freeing the ureter, it is well to place an Allis clamp around it above the stone to prevent the latter's being dislodged upwards. In two of Lower's cases the stones slipped upward beyond reach. The ureter is exposed in front of the clamp, and if possible another Allis clamp applied on the other side of the stone. Between the clamps the ureter is incised longitudinally and the stone delivered. A tapered bougie is then passed into the bladder to dilate any portion of the ureter that may be strictured. If the ureter can be easily sutured, a few stitches with fine plain catgut are taken; if one is in doubt, it is better to leave the ureter open as the sutures may cause pressure necrosis. The vaginal wound is best closed with interrupted sutures of silkworm gut, with a strip of rubber tissue into the parametrium. The Schuchardt incision is closed with continuous layer sutures of chromic catgut, ten day, No. 1. The vagina is packed with iodoform gauze. This prevents, to some extent, any troublesome bleeding that may occur.

The iodoform gauze and the rubber tissue drain are removed in forty-eight hours.

In practically all of the reported cases convalescence has been smooth. In a few drainage has lasted more than a week (in one twenty-one days) but usually it is of only a few days' duration. Six to seven days in bed are sufficient.

My experience with this method has been quite limited, but I believe that in properly selected cases it will prove to be the method of choice.

It strikes me that it is better to free the ureter by a well-planned anatomical dissection, and then remove the stone, than to cut down upon the stone by the sense of touch.

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[For Remainder of References see p. 258.]

NEW METHOD OF INSTITUTING

AIR-TIGHT PLEURAL DRAINAGE*

ARTHUR S. W. TOUROFF, M.D.

NEW YORK CITY

THE occasion to institute air-tight pleural drainage frequently arises in the treatment of empyema and pyo-

FIG. 1. Tube introducer and drainage tube ready for introduction. Note proximal end of tube clamped off.

pneumothorax, especially in children. Two methods of introducing drainage tubes are commonly employed.

The first commonly employed method involves the use of the familiar trocar and cannula. The usual procedure instituted is as follows: A small skin incision is made after the purulent collection has been located with the aspirating needle. The assembled trocar and cannula are then introduced through an intercostal space into the empyema cavity. The trocar is next withdrawn, and the drainage tube, with its proximal end clamped off, is introduced through the lumen of the cannula. Finally the cannula is removed, leaving the tube in place. The objections to this method are as follows:

1. The sudden gush of pus which follows the removal of the trocar sometimes makes introduction of the tube difficult, and often causes a too-sudden decompression of the lung.

2. Air may enter the chest between the time that the trocar is withdrawn and the tube is introduced, regardless of the rapidity with which these manoeuvers are completed.

3. The size of the tube to be introduced is limited by the size of the cannula (whether it be round or oval in cross-section) and by the width of the intercostal space through which it is to be introduced.

4. The tube may be accidentally withdrawn during the process of introduction, because as one attempts to slip the cannula over the tube, after the tube has been introduced, the clamp on the free end of the tube impedes the removal of the cannula. This necessitates the application of a second clamp to the tube, at a point between the chest wall and the withdrawn cannula, before the first clamp can be removed to permit the discarding of the cannula.

The second commonly employed method of introducing the drainage tube may be described as follows: A small skin incision to expose the intercostal space is made in

* From the Surgical Service of Dr. Harold Neuhof, Mt. Sinai Hospital, N. Y. C. Submitted for publication September 4, 1931.

the area at the site of the proposed drainage, after pus has been located with the aspirating needle. The distal end of the drainage tube is grasped between the jaws of an artery forceps, after the proximal end of the tube has been clamped off. The artery forceps grasping the distal end of the tube is then plunged through the intercostal space into the empyema cavity. The objections to this method are as follows:

1. Excessive trauma is produced.

2. If the tube does not enter the chest readily, an attempt to stretch the opening made with the forceps results in the production of an opening which is elliptical in shape rather than one which is round. This further increases the difficulty of introducing the tube. In the meantime, pus may rapidly flow out and air enter, thus resulting in conditions which the surgeon is specifically attempting to avoid.

In an attempt to obviate the difficulties and disadvantages inherent in the aforementioned two methods, a new method which embodies the favorable features of both of the older methods for introducing the tube was devised. This method, which has proved highly satisfactory, involves the use of a new instrument, a tube introducer, which resembles somewhat a long-bladed, hollowed-out nasal speculum. The blades, which are about 2 inches long and

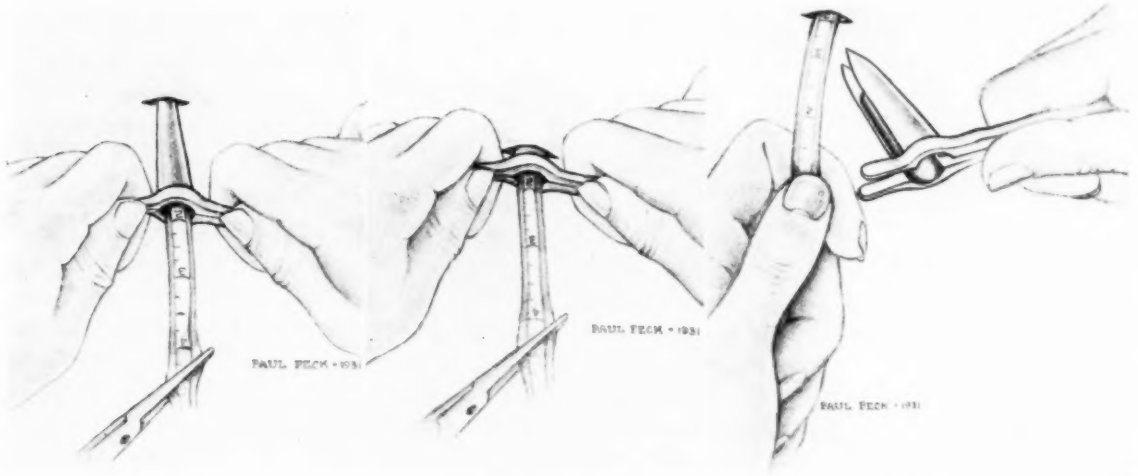

Fig. 2. Fig. 3. Fig. 4.

Fig. 2. Small skin incision has been made. Instrument is being introduced into empyema cavity through an intercostal space.

Fig. 3. Introduction of instrument almost completed.

Fig. 4. Instrument being withdrawn while free hand steadies tube in situ.

3/8 inch wide, taper distally to form sharp points. The instrument permits the introduction of tubes ranging up to No. 32 gauge (French). This size we have found adequate, but if one desires to introduce a tube of larger caliber the instrument may be constructed on a slightly larger scale.

In using the device, the bevelled distal end of the tube to be introduced is placed forward within the hollow of the instrument for as great a distance as will allow the pointed ends of the blades to remain in contact. It is now held firmly grasped by the two broad hollowed-out blades which compress it from above and below. (Fig. 1.) A small skin incision is made and the intercostal space exposed, after the site of drainage has been determined by locating pus with the aspirating needle. The sharp instrument carrying the distal end of the tube is then gently forced into the chest, the proximal free end of the tube having previously been closed by a clamp. (Figs. 2 and 3.) The jaws are next opened, and while the surgeon's free hand steadies the tube, the instrument is withdrawn, leaving the tube in situ. (Fig. 4.) As the

instrument is being withdrawn, the intercostal muscles fall together about the tube, effectively sealing off the opening.

The instrument should always be introduced with the flat surfaces of its blades lying parallel to the long axis of the ribs. A point as low in the intercostal space as possible is chosen, in order to minimize the possibility of injuring the intercostal vessels. There is an area which extends approximately from the posterior axillary line to the nipple line, in which the intercostal spaces are wide and the ribs quite mobile. In this area, the blades can be spread apart readily as soon as they have entered the chest. (Fig. 4.)

In contrast to the area just described, there is a second area which extends approximately from the posterior axillary line to the posterior extremities of the ribs. In this area the intercostal spaces are narrow and the ribs can be spread apart only with difficulty, because of the poor leverage obtainable. When it is necessary to institute drainage here, the instrument is introduced in the same manner as previously described, but before the blades are spread, the handles are rotated clockwise through an arc of 90 degrees. This brings the flat surfaces of the blades to a position at right angles to the direction of the ribs. The blades can now be spread without difficulty because they will not impinge on the fixed ribs, above and below, but on the less resistant intercostal musculature which lies on each side.

If desired, a Pezzer catheter may be employed in place of the usual rubber drainage tube. Its introduction differs in no respect, except that it must be stretched over its stylet while being inserted in order to diminish the diameter of the "mushroom."

The advantages of this new method are:

1. A minimum of trauma is produced.
2. There is little or no leakage of pus to cause too sudden decompression of the lung.
3. Little or no air enters the pleural cavity.
4. While the tube is being introduced, it is not readily displaceable.
5. A large tube can be used, because in certain regions noted above the instrument will separate the ribs if the jaws are widely spread, and thus a large-sized, snugly fitting tube can be introduced. This is an important point in so far as it has been our experience that secondary rib resection and drainage may be unnecessary, if the primary air-tight drainage has been performed using a tube of large caliber.

After the tube has been introduced into the empyema cavity and fixed in place, the free end of the tube can be connected with any type of device with which the surgeon prefers to maintain closed drainage. The clamp is finally released for a variable distance and the lung decompressed at the desired rate.

When this instrument is used in conjunction with the calibrated drainage tubes which we have previously described elsewhere[1] the surgeon is able to readily drain the chest in an air-tight manner, and at the same time introduce the drainage tube accurately to a point just within the empyema cavity without fear that the end of the tube will impinge on the underlying lung.

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BIFURCATION OF THE SUBMAXILLARY DUCT*

BEN-HENRY ROSE, M.D.

NEW YORK

THIS case is reported because: (1) The paucity in the literature of cases of bifurcation of the submaxillary or Wharton's duct; (2) the difficulty in explaining this formation.

CASE HISTORY

A. W., aged thirty-four, female, white, married.

For the past five years, patient had noticed a swelling of the left submaxillary gland with occasional radiating pains to that side of the face, behind the head and neck. Pressure on the gland, externally, brought forth a small discharge on the floor of the left side of the mouth opposite the second molar. Occasionally, pressure over this swollen gland would produce a discharge on the floor of the mouth at the papilla at the side of the frenulum linguae. Most often, however, the discharge appeared opposite the second molar in the back of the mouth. The swelling of the gland would recede from time to time. Of late, the enlargement of the submaxillary gland has been recurring more frequently and has been giving the patient considerable pain. This gland would shrink up and the swelling disappear without any external application. There was no associated disturbance in the patient's teeth, her tonsils had been removed some time previously, and there was no pathology in the mouth itself which could account for the recurrent enlargement of the submaxillary gland.

Physical Examination: On the left side of the neck, below the mandible and in the submaxillary triangle, there was a large, swollen, firm, submaxillary gland not attached to the overlying skin and tissue. There was no fluctuation, nor was it tender to touch. With the mouth open, and with pressure on the undersurface of this gland, one could notice a slight discharge on the floor of the mouth opposite the second molar. There were no other associated glandular enlargements in the neck. The right submaxillary gland was normal. Stumps of previously removed tonsils were found, but no pus could be expressed from them. The remaining physical examination of the body was normal.

Diagnosis: Probable submaxillary calculus.

X-ray Examination: Reveals the presence of a calculus in the submaxillary triangle, apparently in Wharton's duct.

X-ray Diagnosis: Submaxillary calculus.

Operation for the excision of submaxillary calculus and gland, June 16, 1930, at the Yonkers Professional Hospital.

Under gas-oxygen ether, an incision was made on the left side of the neck on the level with the cricoid cartilage over the site of the submaxillary gland. The platysma was reflected. The capsule of the gland was cut and the latter exposed. It was freed of all adhesions surrounding it and lifted up out of the submaxillary triangle. The calculus was felt on the inferior surface of the gland. Inspection revealed that this calculus was situated in what appeared to be a small common Wharton's duct which bifurcated into anterior and posterior limbs: one limb running anteriorly and upwards apparently emptying at the papilla at the frenulum linguae; the posterior limb, apparently of equal caliber, width, and length, running backwards and upwards, seemed to empty in the floor of the mouth opposite the second molar. This accounted for the peculiar symptoms of which the patient complained. Both limbs of the duct were doubly ligated and the gland and calculus were excised. The wound was closed in layers. One small rubber tissue drain was inserted at the angle of the wound.

COMMENT

A search in the literature for cases presenting bifurcations of the submaxillary duct proved futile. In the case reported herein, the posterior limb may in reality have been a fistulous tract which occurred behind the obstruction caused by the

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calculus. It is possible that that portion of Wharton's duct behind the calculus may have become cystic and that this cyst, after suppuration, may have possibly but not necessarily, discharged itself into the mouth opposite the second molar. There would then have been two tracts, both opening into the mouth, one the real duct and the other a fistula with a fairly distinct wall, closely resembling the original Wharton's duct. If a cyst had occurred, as suggested, it would have disappeared as such at the time of the operation, its wall being represented as the posterior duct. The difficulty in accepting the posterior limb of the duct as such is entirely due to the difficulty in explaining in detail how this bifurcation may have arisen. The salivary glands are generally supposed to be ectodermal in origin, that is to say, derived from the stomodeum and not from the embryonic (entodermal) pharynx. The stomodeum is believed to form only a small part of the floor of the mouth (the part anterior to the tongue) although it forms the whole of the roof. If the submaxillary gland is really ectodermal, its duct (the stalk of the gland, so to speak) is not likely to arise from a part of the mouth known to be entodermal in origin. There is great difficulty, however, in determining the exact boundary the ectodermal and entodermal regions of the mouth and there is therefore some doubt as to whether the entoderm does not take some share in the formation of the salivary glands.*

* Senior, Prof. H. D. Personal Communication.

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* Continued from page 253.

BIOPHYSICAL FACTORS CONCERNED IN THE CLINICAL COURSE OF CARCINOMA OF THE UTERINE CERVIX*

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PREDILECTION OF CARCINOMA FOR UTERINE CERVIX. The predilection which genital carcinoma unquestionably shows for the cervical portion of the uterus is so striking that the reason might well be sought in the developmental background or in some anatomical or physiologic peculiarity of the structure which this neoplasm selects in adult life. It is not the incidence of cancer that is considered in this study, but rather the biological and physical factors which play a part in its subsequent behavior.

EFFECT OF MUSCLE TISSUE ON CANCER EXTENSION. When in the course of developmental evolution, the upper portions of the two ducts of Mueller become the fallopian tubes, the middle and lower portions coalesce to form the uterus and vagina, hollow muscular organs which are covered with peritoneum and lined by mucous membrane.

An invading carcinoma does not perforate preformed muscle layers readily, but grows along the natural planes of cleavage where the lymphatics lie. The general disposition of the muscle tissue therefore may have a certain bearing on the way in which carcinoma extends in a muscular organ. It is not difficult to see why this applies rather to the spread of carcinoma in the body of the uterus than in the cervix itself.

CARCINOMA SPRINGS FROM EPITHELIUM. Carcinoma is an epithelial neoplasm. While muscle planes and connective tissue spaces which lead to lymphatic routes may help to determine the paths of least resistance, these tissues must nevertheless be subordinate in their significance, to the epithelium itself from which the cancer springs.

At that moment when the normal behavior and potency of embryonal as well as adult tissue are more clearly understood, it will become easier to detect the epithelial aberrations which take place in cancer.

Scanned from the developmental viewpoint, the epithelium of the vulva, including the vestibule, is ectodermal, while that which belongs to the vagina, uterus and tubes, the structures derived from Mueller's ducts, is mesodermal. Histologically speaking, stratified squamous epithelium continues from the cutaneous to the mucous surface of the labia majora. It covers in continuity the vulvar mucous membrane, the vaginal canal and vaginal aspect of the cervix. At the external os, normally, is the line of transition to the single layered columnar epithelium which invests the cervical canal and uterine cavity and extends throughout the fallopian tubes.

CHARACTER AND DISTRIBUTION OF EPITHELIUM. The epithelium which protects the vagina and exocervix is therefore of the same general structure as that which covers the surface of the body and is better adapted to withstand insults than the delicate cylindrical epithelium in the less exposed and more inaccessible uterotubal segment.

CONGENITAL PSEUDOEROSION. When in the third month of intrauterine life, the indifferent epithelium of what is to become the fetal cervix differentiates into the glandular or "cylindrical" and the squamous types, the squamous epithelium at first lines a large part of the cervical canal but is later encroached upon by the maturing glandular epithelium with its glands and mucous cells. In fact even an extension of the glandular epithelium beyond the

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external os may be apparent after birth and constitute what has been called the congenital pseudo-erosion.

Epitrachelitis Granulosa. In *adult* life, the normal line of transition is at the external os. An ectropion, or eversion of the endocervix which is due to a cervical laceration, is to be distinguished from the true erosion which is perhaps more accurately designated *epitrachelitis granulosa* or simply, circumscribed epitrachelitis.

Reciprocal Relations of Squamous and Cylindrical Epithelium at External Os. When the endocervix is in a catarrhal state, there is increased desquamation of the vaginal portion of the cervix or exocervix so that some areas may be completely deprived of epithelium, particularly near the external os from which the cervical discharge issues. Under these circumstances the conditions are favorable for the extension of the translucent endocervical epithelium to the denuded area. There may be a small patch of migrated endocervical epithelium covering a deep red surface of the anterior and posterior lips, or it may encircle the external os completely.

When the cervical discharge ceases or the area is treated by repeated application of a solution of silver nitrate, the erosion disappears and squamous epithelium again takes its place. This reciprocal replacement depends not so much on a hardier growth as on whether the local conditions are more favorable for the proliferation of the one or the other type of epithelium. Thus the catarrhal discharge which accompanies cervical inflammation causes the surface epithelium to be cast off in patches and macerates it, while the glandular epithelium is relatively tolerant and may even grow out over a raw area before the inflammatory exudate has disappeared.

Micromechanics of Epithelial Cell Replacement. The ingrowth of new squamous epithelium takes place from the basal layer. At first the advancing edge is thin and tapering. The basal cell grows in height and the nucleus divides. One daughter cell is pushed toward the surface to undergo further differentiation into a polygonal form initially and finally to become more flattened in order to serve its protective purpose. The other daughter cell merely replaces the parent cell in the basal layer. Other basal cells however undergo cell division in a different plane, so that the cells in the basal layer also become numerically increased.

The effect of cell division in the basal layer is therefore twofold. While the thickness of the polygonal and squamous cell strata becomes more pronounced, the multiplication of other basal cells leads to crowding in the basal layer and creates an undulating outline. When cell-division becomes greatly exaggerated as the result of recurrent irritation from local inflammation of low grade intensity, actual downgrowths of the basal epithelium occur.

Effect of Local Irritation. Under these conditions of irritation the young cells are provoked to undergo cell-division prematurely and under the stress of irritation the offspring becomes progressively more atypical. Cell reproduction is impelled to continue under morbid conditions. In the beginning the cellular metabolism is merely exaggerated. Anabolism is active and the reserve supply is sufficient. But rapidly the process of dissolution exceeds the assimilating activities within the deteriorating cells. Even the staining properties reveal the serious derangement in the intracellular processes. The irregular nuclei are blurred in outline and the cells look as if cytoplasmic material had escaped into the surroundings. The alignment of the basal layer may be broken and cells make their escape into subjacent tissues. K. V. Bailey has recently made some excellent studies in these directions and attempted to establish a relationship between the micromechanics of epithelial behavior in recurrent infective inflammation of the cervix and incipient cancer.

Difference between Irritation Forms and True Tumor Cells. So far, it has not been shown conclusively that

the atypical irritation forms which occasionally are seen in inflammatory lesions may acquire autonomy in the sense that they can continue to divide anomalously either when the irritation ceases or after the removal of the irritated cells by metastatic displacement; and this is the keynote of the requirements imposed by malignancy.

Significance of Trauma. Formerly mechanical irritation as well as chronic inflammation was held to be intimately associated with tumor production. With a broader view of the biological character of cervical cancer much less importance is attached today to the relation of mechanical irritation or trauma to tumor incidence. If there were anything determining in the laceration itself, why does the carcinoma not, as a rule, have its beginning in or near the actual site of the injury? Since cervical tears most commonly are lateral, why does the carcinoma usually start in the anterior or posterior lip instead of beginning in the cervical angle? If the carcinoma is closely related to the tissue damage which has been sustained during childbearing, why do the statistics of the Woman's Hospital of New York City according to Lilian K. P. Farrar show that in 41.7 per cent cervical cancer occurs as late as ten to twenty years after the last pregnancy? And 24.4 per cent not until twenty to thirty years have elapsed? In a recent discussion, it interested me greatly to learn that H. Schmitz contends that cancer of the cervix is not more frequent in women who have borne children than in those who have not, and offers his own statistics to substantiate this. In the New York City Cancer Institute, in the period between May, 1923 and November, 1929, there were in my service 592 carcinomata of the uterine cervix and during the same time span there were observed only 23 malignant epithelial new-growths of the vulva. This ratio between cancer of the cervix and cancer of the vulva is in approximate accord with other statistics. Why is it, that cancer of the vulva is so rare in comparison with cancer of the cervix when these structures are scarcely less subject to obstetrical wounds at parturition?

Significance of Ovarian Function in Cancer Incidence. Now and then it is asserted that ovarian function has a determining influence on the incidence of uterine carcinoma. If this were the case, the influence must be more remote than for any other pelvic neoplasm. If the menstruation may be taken to reflect disturbances in ovarian activity, habitual menorrhagia is characteristic in myoma of the uterus while in the case of many ovarian growths, on the contrary, an early history of hypomenses can be obtained. In cancer of the cervix however, there is usually no evidence of any prognostic upset in the early menstrual modus which is often, in the main, normal in quantity, character and duration.

Not All Epithelium Is Equally Capable of Malignant Response. Cancer is essentially a disease of the blastogenic or tissue-forming cells, and not of the formed tissue cells after they have largely lost their power of reproduction. In order to display the attribute of promiscuous proliferation, cancer must come from those cells in a given district, that even under physiological conditions respond to the call for cell-division or by which the epithelium is normally replaced. The restoration of squamous epithelium primarily takes place from the basal layer. The reproduction of gland epithelium to fill in the ranks of that which has perished subservient to its function, depends on the cell-division of prismatic cells which are not specialized or highly differentiated. At that moment when there is added to the downward growth and disruption of the regular basal layer, positive evidence of heterotopia, carcinoma is *probably* demonstrated because with the heterotopia extension and metastasis begins.

Glandular and Epidermoid Cancers. The cancerous growths of the cervix are sometimes adenocarcinomata, but by all odds the greater number of cervical cancers

are epidermoid carcinomata. In a general way, it may be said that the adenocarcinoma arises from the cervical canal while the epidermoid growths spring from the exposed surface of the cervix. The provision however must be made that their origin may be anatomically ectopic when epithelium from the cervical canal has found its way to the vaginal aspect of the cervix as in erosions; or conversely when squamous epithelium has grown inward upon the lacerated and everted endocervix. More significant is the general conception that adenocarcinoma has its origin from epithelium which is capable of producing glandular structure and in very rare instances, even differentiating its cells into typical mucus secreting cells; also, on the other hand, that epidermoid cancers most likely have their genesis in the germinal layer of squamous epithelium, the Malpighian layer, the biological trend of which is to reproduce the epidermal structure when the conditions of tumor growth permit sufficient differentiation.

Types of Epidermoid Carcinoma. According to the dominating microscopic appearance, epidermoid carcinomata can be divided somewhat arbitrarily into three groups. The one is marked by the undifferentiated and anaplastic cells which constitute it. The other exhibits a more or less advanced differentiation of its elements and reflects plainly the epidermal characteristics in its prickle cells, epithelial pearls and keratin formation. Finally, the largest group clinically is the one which occupies an intermediate position between these two histological extremes and is identified chiefly in a negative way by the absence of notable anaplasia and the lack of pearl formation or hornification.

Relation between Types and Biological Malignancy. The anaplasia indicates the biologically most malignant type of epidermoid cancers; the well differentiated tumor is less active in extending and disseminating. To what extent however, in a particular individual, the biological malignancy will display itself clinically is sometimes a different matter, for clinical experience shows that what is morphologically the same tumor does not thrive and grow in the same manner in every host. In this lies the distinction between the biological and the actual clinical malignancy manifested by a growth.

Significance of Size of Tumor Cells. Cullen and Lubarsch correlate the small cells in tumors, with their infiltrative propensities. Very likely the actual size is less vital in this connection than their anaplastic character or biological malignancy as expressed in the rate of cell-division. When the rate of cell-division is abnormally increased many young and immature cells, which have had very little time to grow, appear in the field. With reference to the size of the parent epithelium, it is of interest that the prismatic epithelium of the cervical canal is fully twice as high as that in the uterine cavity, although adenocarcinoma of the cervix shows a decidedly greater invasive tendency than adenocarcinoma of the uterine body.

Filar Structure of Normal Cell. Fleming, in his studies of the normal cell, distinguishes a filar structure of the cytoplasm and an unorganized interfilar substance. The cilia of the tubal, uterine and endocervical epithelium are projections from the living protoplasm of these cells and may be interpreted as continuations of the filar elements. In some locations elsewhere the "cylindrical" or prismatic epithelium has a striated surface seam instead of definite cilia. The projection of the filar elements from the surface of epithelial cells in the form of fine processes appears to be a general occurrence. By special methods it has been demonstrated even in cells of the squamous layer in stratified epithelium. The well-developed filamentous intercellular connections between the polygonal cells of the dentate layer of the epidermis can probably be explained in this way. These intercellular bonds have also been found to connect the prismatic cells of the basal layer and even

penetrate the connective tissue base upon which they rest. All this suggests that after cell-division, the cells still remain in organic connection and the filar bonds continue to be unbroken. These cellular connections are more or less perfectly reproduced in cancer and probably determine whether the tumor cells extend by growing along the lymph paths in continuous chains or readily detach themselves from their fellows to become displaced by metastasis.

Boundary of Normal Cell. In considering the relations of the individual cell to its surroundings, the character of its boundary has no doubt an essential bearing, for the intake and the output of the cell are dependent on this. In immature or new-formed cells presumably there is no very definite limiting cell membrane; the protoplasm may be merely condensed at the periphery.

Shape of Cells. The actual shape of a particular cell is only of incidental significance. It is dependent largely on environmental pressure. If the cell were isolated, it would probably assume a round or oval shape. When the pressure comes chiefly from one direction the cells are flattened as when the cells approach the surface in squamous epithelium. Where the pressure is exerted from all sides by other cells of the same kind, the forms are apt to be polygonal as in the intermediary layer of stratified epithelium. Subjected largely to lateral pressure, the "cylindrical" or prismatic epithelium is actually polygonal or hexagonal on cross section; for this reason, the term "cylindrical" is not well chosen. The selfsame forces may influence the morphology of tumor cells but the part which they play apparently becomes the more subordinate, the greater the rapidity of the growth.

Interepithelial Spaces. The epithelial cells are not in direct bodily contact with one another but between them are miscroscopic clefts or intervals, intercellular spaces, which are filled with a fluid or liquid intercellular substance. This represents partly food supply for the cell and partly secretion and waste material from the metabolism which goes on in the cell.

In the skin it has been possible to inject these intercellular spaces through the lymph vessels of the region, which appears to show that these are in communication. In the case of single layered epithelium, superficial leakage from the intercellular clefts is prevented by a sealing of these clefts near the surface, perhaps by condensation. Important above all, as far as the relations in the cervix and vagina are concerned, is the connection of the interepithelial spaces generally with lymph paths which lead to a plexus of mucosal lymphatics and from this to a larger network which lies in a more external layer and is directly connected with the regional lymphatics and lymph nodes.

General Scheme of Lymph Drainage of Uterine Cervix. Most of the regional lymph nodes which directly or indirectly receive the drainage from the cervix are situated centrally and distally about the bifurcation of the common iliac artery on each side of the pelvis. So there are small groups placed along the internal and external iliac arteries, also along the common iliac arteries up to their aortic origin. Another smaller group lies in the hollow of the sacrum.

The lymphatic radicles from each half of the cervix connect a meshwork of finer lymphatics in the mucous membrane with a coarser surface plexus which is partly subperitoneal. From the upper part of this surface plexus a number of lymphatics can be traced in a plane somewhat above the ureter, to the regional nodes which are aggregated about the external iliac vessel. From the middle district of this plexus, lymph vessels which are in close relation to the ureter at the base of the broad ligaments, drain into a group of nodes in the proximity of the internal iliac artery. Arising from the inferior portion of the plexus, a third bundle of lymphatics can be found in a level below the ureter and traced back between the peritoneal layers of the sacrouterine ligament behind the

rectum to the sacral lymph nodes. These relations have been carefully defined by Poirer, Cuneo and Marcille.

Lymph Drainage of Upper Vaginal Segment. The upper one-third of the vagina or that segment of the vagina which is in the closest relation to the cervix, has a drainage scheme which in the main points is not unlike that of the lower or vaginal portion of the cervix. The vaginal drainage on each side is directed laterally into the internal iliac lymph nodes; other lymph channels pass posteriorly and communicating with rectal lymphatics, drain into the sacral nodes. In the vagina however the plexus of fine mucosal lymphatics lies more closely beneath the epithelium and in turn this mucosal or subepithelial plexus is connected with a coarser meshwork which lies in the submucous layer.

These considerations make it readily comprehensible how epidermoid cancer which quickly spreads from the exocervix or portio to the vaginal juncture necessarily must direct its drainage along lymph paths which run in the cellular tissue at the base of the broad ligaments laterally, and the sacrouterine ligaments posteriorly. It is also evident that the peculiar arrangement of vaginal lymphatic communications affords an explanation for the frequent occurrence of isolated or encircling secondary deposits in the vaginal mucosa.

Permeation of Lymph Paths by Cancer Cells. From the impression, at first that little more than the normal resiliency and suppleness of the cellular tissue is lost, or that thin hard strands are present or definitely beaded cords which represent lymph vessels impacted with cancer cells, there may be any intermediate stage, to solid infiltration of nearly all of the cellular tissue between the broad and sacrouterine ligaments on each side with complete fixation of the uterus.

Rectovaginal Examination in Ascertaining Clinical Stage. An early trend of epidermoid cancer of the cervix toward the sacrouterine folds will scarcely be overlooked by those who are familiar with these important details of regional drainage. The inadequacy of the usual vaginal examination and the necessity of rectovaginal palpation for the proper investigation of the condition of the sacrouterine ligaments is apparent. At the Cancer Institute it has been the practice in the service to complete or supplement the clinical findings which were obtained on admission by a careful review under spinal analgesia while the patient is prepared for surgery or radiotherapy. No other form of anesthesia yields such complete relaxation for palpation of the pelvic organs.

Some Factors in Mechanics of Extension. The natural linking of epithelial cells is not, at once, sacrificed when the cell becomes cancerous. How well the intercellular bridges may be reproduced in a tumor is illustrated in the typical acanthoma. When the cell becomes cancerous for whatever intrinsic reason, and asserts its autonomy by hectic cell-division, the extension of the growth occurs along the lines of least resistance.

At first the proliferating cells dissect their way with some difficulty along the narrow lymph spaces in the connective tissue until the larger radicles of the lymphatic system are approached.

The extension is in chains or columns which may be uninterrupted until the regional lymph nodes are reached. Handley has shown that this is frequently the case in cancer of the breast. Occasionally the entire subperitoneal lymphatic plexus of the uterus can be seen to be filled with closely packed cancer cells. The beaded bands, which sometimes can be felt in the sacrouterine districts on rectovaginal examination, represent extensions in continuity along the lymph paths leading to the sacral nodes.

How Metastasis Occurs. Only when the cells become detached and are set afloat in the lymph stream, does a true metastasis take place. Considered from this angle, the occurrence of metastasis is an incident, a complication in the process which obtains in malignant disease. Most

of the metastases in cervical cancer, when they do occur, are regional, but probably more frequent than is at present assumed, is the involvement of the regional adenoid masses and nodes due to direct extension.

H. Ribbert demonstrated in the connective tissue about inflammatory foci, small disseminated adenoid masses consisting of lymph-cells ensnared in a fine reticulum. Some of these had apparently developed by hyperplasia from tiny preexisting clusters of lymph-cells and others were entirely new-formed from lymph-cells which had been deposited there during the lymphostasis that accompanies the inflammation.

Role of Adenoid Tissue. Similar adenoid masses are found in the outskirts of cancerous growths. These are either newly formed, or incited to increase in size through hyperplasia, by the action of certain products which emanate in the primary growth and escape into the lymph current, or by some transferred tumor cells which have been destroyed. Such masses of adenoid tissue may intercept detached cancer cells and harbor them, and, in a sense, determine the location of small metastatic deposits. The difficulty of eradicating all these foci in the course of operation for cancer explains the frequency of recurrence. Fortunately the growth of implanted cancer cells is not fostered by lymphoid tissue. Because of the uncongenial environment, the cancer cells may remain dormant for the time being or perish. Cancer of the uterus has reappeared as late as fifteen years after operation. This seems to show that the proliferating activity may be held in check for long periods without necessarily destroying the ectopic epithelial cells.

Part Played by Regional Lymph Nodes. On the whole, the anatomical conditions that obtain in the lymph nodes are conducive to lymph stasis. A number of larger ingoing lymphatics break up into wide intercommunicating capillaries which surround both the cortical and medullary aggregations of adenoid tissue that constitute the lymph node. A fine reticulum supports the lymph capillaries and adenoid masses. This has its origin from numerous fibrous processes or trabeculae which are derived from the capsule of fibrous connective tissue that surrounds the lymph node and septa which penetrate its interior.

The outgoing lymphatics in which the lymph is again collected, are of smaller caliber and fewer in number than those which enter the node. The lymph capillaries or sinuses are disproportionately wide and sacculated and crowded with escaping lymphocytes. It is not difficult to see what happens when a cancer embolus drifts into these surroundings. According to Ribbert, cancer cells are at first lodged in the peripheral lymph sinuses of the node and partly or completely surround the cortical adenoid masses. Gradually the deeper portions are involved, until the adenoid tissue is completely replaced by cancer.

The cortical adenoid masses of the nodes contain the main germinal centers in which the multiplication of lymphocytes takes place; while the relative infrequency of mitotic figures indicates that there is but little germinal activity in the medullary portions. It seems likely, and this tallies with the behavior in inflammatory disease but is difficult to prove, that products or cells arising from the primary growth initially irritate the regional lymph nodes sufficiently to induce a catarrhal desquamation of the endothelium of the lymph sinuses and call for an increased production of lymphocytes in the germinal area with lymphocytosis and hyperplasia. At any rate, these are the changes that seem to antedate the visible embolic lodgement of cancer cells. Fundamentally the new environment of the alien cells is not favorable to their growth. If this were the case, metastatic growths at the site of the regional lymph nodes would be a common occurrence. Instead, limiting fibrosis with encapsulation of the tumor cells is the not infrequent outcome.

Cancer Bed. The area from which the cancer originally grows is conveniently called the cancer bed. Radiotherapy, in

order to be effective, must be directed toward this area rather than to the exophytic mass that may have arisen from the germinating tumor base. Particularly is this vital if any result is to be achieved when radon seeds are used.

Tumor Degeneration and Infection. The decadent portions of the tumor are significant only because they become invaded by putrefactive and pathogenic organisms and give rise to ulceration, excavation, crater-formation, bleeding, and discharge. The toxemia which is due to local infection and not to products of the tumor itself is often the chief factor in the patient's invalidism. As soon as the local asepsis is more or less perfectly restored, a relative measure of well-being returns.

A blocking of the cervical canal by the exophytic cancer masses may lead to pyometra. Rarely the distended uterus reaches the size of a cocoanut. When this occurs in women after fifty, the constitutional disturbance may be very slight; frequently the temperature is scarcely elevated although when a dressing forceps is introduced, a large quantity of pus escapes and the tumor, which was palpated in the hypogastrium, disappears.

In general it may be assumed that, as soon as the surface of a growth is broken, the tumor tissue becomes invaded by bacteria. Putrefactive bacteria play a large part and give rise to some general intoxication. Much more menacing however are the pathogenic organisms, the staphylococci and streptococci. It is the streptococcus particularly that permeates, and seeks the lymph paths of the parametrium. A rise of temperature, local pain and tenderness in such an instance plainly indicate that an active septic parametritis exists and that surgical or radiological measures must be postponed.

Clinical Peculiarities of Adenocarcinoma. An adenocarcinoma which starts in the cervical canal characteristically remains within the confines of the external os, although it may have progressed to such an extent that the disintegrating tumor has completely excavated the cervix leaving only a thin shell of the exocervix. Even then very little change in the surface appearance of the cervix may be evident excepting a slight irregularity in the outline of the external os. The presence of the tumor is established beyond doubt when the probe no longer discerns the smooth cervical canal, but in its place a cavity with crumbling, readily bleeding walls. While encroachment upon the squamous covering of the portio is so strikingly avoided by the glandular carcinoma, it may even extend upward beyond the internal os into the lower uterine segment and show metastatic deposits in the cavity of the uterus.

Clinical Characteristics of Epidermoid Cancer. The cervical cancers which are usually seen are of the epidermoid type, and springing from the stratified epithelium exhibit a tendency to follow this epithelium beyond the confines of the exocervix along the fornix into the vagina. Even after much destruction, the epidermoid cancer does not quickly pass the barrier of the internal os and metastatic deposits, as a rule, are not found in the uterus.

Speculum Picture of Epidermoid Cancer. In the everyday routine, most of the cervical carcinomata that can be viewed directly by means of the vaginal speculum are epidermoid in character. There may be a dark or dusky red patch with a raspberry surface which bleeds easily on contact, or a larger exophytic mass projecting as a cauliflower-shaped growth. The tumor surface may have broken down and a greyish, greenish or blackish slough gives rise to a characteristic malodorous discharge.

Vaginal Involvement. The destruction then involves most of the vaginal portion of the cervix leaving a crater-like pit with an elevated brim which is not a part of the cervix but is formed by the encircling invasion of the vagina. Sometimes other crescentic or completely annular vaginal deposits occur two or three centimeters distant from the crater edge,

while the intervening segment of vagina retains its normal suppleness to palpation. Again, isolated deposits may be found in any part of the vaginal wall. These secondary aggregations involve the mucous membrane and are probably due to metastasis by tumor cells which have found their way to the subepithelial lymphatics. Their permanent disappearance after the implantation of radon seeds and the absence of new aggregations in their immediate vicinity emphasizes the impression that they are often truly metastatic.

If the distance of the advancing crater edge from the introitus is recorded from time to time, the rate of vaginal invasion can be established. It is found ordinarily that the progression is most rapid along the anterior vaginal wall. When the status is taken, the distances are estimated digitally at the four cardinal points and the numbers dictated, for convenience, in a clockwise order. Enlargement of the *pubic* lymph node, as it may be called, is observed only when the invasion has reached the vaginal outlet. The *pubic* node is one of the inguinal lymph nodes and lies in the inguinal region close to the pubic spine.

Implication of Bladder and Urethra. As the neoplastic disease advances, the vesical wall becomes infiltrated by direct extension of the primary growth in the cervix and metastatic deposits occur in the submucous layer. Notwithstanding the fact that the bladder is closely attached to the cervix just below the peritoneal recess of the anterior cul-de-sac, clinically speaking it is not seriously involved until the carcinoma has made considerable headway along the anterior vaginal wall. Invasion of the urethra rarely leads to actual blocking which requires intervention. A vesicovaginal fistula forms only in about one-half of the advanced cervical carcinomata. The others succumb to the adjuncts of the neoplastic disease before this complication results. Sometimes it seems that the coexistence of tertiary syphilis exerts a favorable rather than an unfavorable influence as far as local sclerosis is concerned. At least, in two such instances at the Cancer Institute the connective tissue response was certainly unusual. In one, locally the advance of the cancer seemed actually arrested and an existing vesicovaginal fistula about 2 by 3 cm. in size was converted by fibrosis into an oval communication with a white hard, smooth border. Nevertheless it may be that this behavior was, after all, coincident and not etiologically related.

Hydroureter, Hydronephrosis, Chronic Nephritis, Uremia. The ureter can be completely imbedded, as it were, in a lava of cancer, while its muscle coat still resists perforation. The obstruction which so frequently occurs seems to be due to compression from cancerous infiltration and supervening swelling from secondary inflammation with edema and exudate. Dilatation of the ureter, hydroureter, and hydronephrosis, chronic nephritis with gradual suppression of the renal function constitute the sequence which leads to chronic uremia and is the most common immediate cause of death. The euthanasia of the terminal stage is largely due to the uremic poisoning.

Bowel Involvement and Rectovaginal Fistula. Fistula of the posterior vaginal wall does not occur as readily as anteriorly. This is explained by the tardier invasion of the posterior wall and the fact that it may be involved to the extent of 2 or 3 cm. before the lower angle of the posterior peritoneal cul-de-sac is reached where the vagina is contiguous with the rectum. The altered surface of the rectal mucosa and its attachment to the invading tumor can be detected weeks before the fistula actually forms. Not infrequently the growth encroaches upon the lumen of the rectum carrying mucosa in front of it and causing a partial obstruction of the colon. The site of predilection is usually near the rectosigmoid angle. Seldom is the obstruction so complete that the bowel cannot be emptied by means of the rectal tube. So greatly lowered is the vitality of these unfortunates that the outcome, even of a simple colos-

tomy under local or spinal anesthesia, is doubtful.

Three Clinical Stages of Cervical Cancer. It is customary to assign patients suffering from cervical cancer to groups according to the clinical stage of the neoplastic disease. To the first group belong those in whom the carcinoma is still confined to the cervix; in the second group are those in whom the tumor is beginning to transgress the limits of the cervix and either invades the parametrium and the cervicovaginal juncture as in epidermoid growths, or the parametrium and the internal os as in glandular carcinoma. The third group embraces all the patients with advanced neoplastic disease and it is specified, in addition, when a vesicovaginal or rectovaginal fistula exists.

Invasion of Parametrium. Unlike carcinoma of the body of the uterus, the invasion of the parametrium occurs along the base of the broad ligaments while its free border which contains the fallopian tube and related structures remains relatively free of involvement. In the undifferentiated, anaplastic types the invasion is prompt while in the well-differentiated types of cervical cancer the broad ligaments may exceptionally give no palpable evidence as late as six months after the tumor incidence. In this respect the plexiform type together with the glandular carcinoma occupy an intermediate position. In these considerations it makes a decided difference whether the neoplastic disease appears in the decades before or after the age of fifty. With menopausal involution, the pelvic lymphatics become atrophied and to a varied extent the passage of the cancer cell is impeded. Potentially, senility creates a situation similar to that which is induced by high voltage *x*-ray therapy although the tissue process is histologically different.

Edema of Vulva and Lower Extremity. The pathways of invasion are determined, to a large extent, by the anatomical lines along which the regional lymph drainage takes place, the spread of the neoplastic disease is both lateral between the layers of the broad ligament and posterior along the sacrouterine folds. Eventually the ligamentous anchorage of the cervix, through one or more of these ligaments, become rigid and the primary tumor site, which is usually converted into a discharging crater, is fixed in the pelvis as the process extends along the cellular tissue to the pelvic wall. Edema of the vulva and lower extremity is likely to indicate this advanced stage, when the return flow in the iliac veins is impeded by cancerous nodes near the bifurcation.

Nerves Involved. At the same time, the lymphatic sheaths of nerve trunks may be extensively invaded and atrophy of the medullary sheaths and obliteration of the axis cylinders is caused by pressure. Persistent pain is complained of in the gluteal region and back of the thigh and this may make walking difficult.

Dissemination of Cancer through Blood Channels. Unlike sarcoma it is not characteristic of carcinoma to invade blood channels. This occurrence in cancer of the uterine cervix is often a late complication. In some instances it seems that this sequel is invited particularly when there is marked secondary involvement of the rectum. Through the hemorrhoidal plexus of veins which surround the lower portion of the rectum, a direct connection is established between the portal and systemic venous systems. If, incident upon the formation of a rectovaginal fistula, the hemorrhoidal plexus is eroded and a cancer embolus gains access here, there are two anatomic paths which the embolus may follow.

Picked up by its superior hemorrhoidal branches, the inferior mesenteric vein carries the embolus into the splenic and thence into the portal vein to the liver.

Otherwise, the internal iliac vein is reached from its middle and inferior hemorrhoidal radicles and the detached cancer cells are delivered by way of the common iliac to the inferior vena cava,

the right heart, and finally lodged in the pulmonary arterioles.

The vaginal plexus of veins which communicates with the vesical plexus in front and the hemorrhoidal behind, is chiefly concerned where the posterior involvement is less extensive, as is the rule, and fistula formation occurs anteriorly. In this situation portal metastasis, anatomically considered, is less likely than systemic.

When the vaginal invasion is not a factor, as in glandular carcinoma of the cervix, hematogenous metastasis comes through the uterine plexus and therefore tends to have its destination in the lungs.

In the main points, autopsy has confirmed the general impressions obtained from anatomical and clinical considerations that have to do with the reason why such metastases occur and what determines their localization.

Cancer Thrombus and Embolus. According to M. Schmidt, carcinoma may penetrate a blood vessel by way of the perivascular lymphatics. Fibrin is deposited and a thrombus forms at the site of penetration. The thrombus may go on to organization and fibrosis and the entangled cancer cells may be destroyed. When however cancer cells gain a foothold on the wall and grow within the vein, they produce endophytic projections into the lumen. These grow to a greater or lesser extent until they become detached and are carried along the blood stream.

It appears that only a small number of the tumor emboli that are implanted in the pulmonary arterioles eventually prove to be the source of secondary growths in the lungs. Thrombus formation with organization and incarceration of the cancer cells, Schmidt concludes, is a frequent outcome although the malignant epithelium may remain viable and under proper conditions give rise to late metastases.

Skeletal Metastasis. In the skeletal system, metastasis is so unusual in cervical cancer, that its radiographic demonstration calls for a critical review of the primary source. In one instance in which a large metastatic deposit was detected in the head of the humerus, the cervix involvement on admission closely resembled a carcinoma but was afterward interpreted both histologically and clinically as a chorioepithelioma.

The intensive study of cancer of the uterine cervix opens many new lines along which useful observations can be made. Some of these problems also have a larger significance in the general understanding of cancer. With this in mind, a better correlation must be sought between the biological and the clinical.

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OPEN COMMUNICATION BETWEEN APPENDICEAL MUCOCELE & CECUM*

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THE conception of the pathogenesis of localized or diffuse distention of the appendix by thick gelatinous mucoid material has practically always presupposed complete or almost complete occlusion of the lumen proximal to the dilated portion, absence of pathogenic organisms, and an actively secreting mucosa. In most cases reported no mention is made as regards the patency of the proximal portion of the organ and attention has been concentrated upon the method of escape of the jelly-like liquid into the abdomen, and its relation to pseudomyxoma peritonei.

That a mucocele can form without complete occlusion at the proximal end is proved by Vorhaus who described the process in a forty-six-year-old woman giving a history of several attacks of pain and a small palpable mass in the right lower abdominal quadrant which upon several occasions showed an irregularly barium-filled appendix that proved to be, at operation, a mucocele 12 cm. in length and 5.5 cm. in circumference, involving the appendix and lower cecum. Although there is no detailed pathological report, it must be assumed that the lumen may have been closed at times but that the obstruction subsided in order to admit the barium. Dodge, in recording a study of 142 cases found that in 37 the lumen was studied, and in 5 of these the lumen was closed or partially closed.

The case to be reported exemplifies the patency of the proximal portion of the appendix as visualized on fluoroscopic and pathologic examination of the removed organ. The history elicits repeated exacerbations of an inflammatory process.

A white female, aged twenty-five years, married three years, was admitted to the hospital March 27, 1930, with the following:

History. Seven months before entering the hospital she suffered her first attack of cramping pain in the periumbilical region. In two hours this became more and more severe and gradually localized to the right lower quadrant of the abdomen. This was accompanied by nausea and vomiting on three occasions, and some fever. In the course of three days with application of an ice bag and rest in bed these symptoms subsided. Following this the patient had constant abdominal "soreness" which was most marked on the right side and occasionally became sharp but did not radiate to any other part of the abdomen. In December of 1929, three months after the onset of clinical manifestations, she experienced a similar seizure of abdominal discomfort; however, on this occasion it was more severe in the epigastrium and radiated to the right shoulder and scapula but was not accompanied by vomiting. These symptoms led another physician to regard the entire picture as the result of a diseased process of the gall bladder. Following this, until her entrance, there was more or less continuous epigastric discomfort, repeated belching unrelated to the ingestion of food, rather marked constipation, and a loss of about 10 lb. in weight.

The history referable to the pelvic organs did not point to any lesion to account for the complaints in the right lower abdominal quadrant. However, she had had a forceps delivery, of a normal infant, fourteen months previous accompanied by a laceration of the perineum which was sutured at the time. The post-partum course was afebrile. Her menstrual periods were regular and of five days' duration

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until three months before operation but from that time she bled every three weeks, for seven days and passed small clots of blood but had no pain.

Eating, urinating, or defecating had no relation to the pain.

Physical Examination. The patient was apparently emaciated, weighing only 97 lb., and presented a sallow pale brown appearance of the skin. The essential findings were confined to the abdomen. The abdominal wall was 2 to 3 fingers below the level of the chest and the anterior wall was soft in all areas. The cecum and sigmoid were palpable and tender and lateral traction in the former region resulted in pain at the site which also radiated towards the umbilicus. The edge of the right hepatic lobe was felt 2 fingers below the right costal edge and was slightly tender. She offered no complaints on pressure in the region of the gall bladder. The lower one-third of the right kidney could be felt on deep inspiration.

Bimanual pelvic examination demonstrated a slight bilateral healed laceration of the cervix. The corpus uteri was small, in axial position, and the appendages were free from any palpable pathological changes.

The urine was devoid of any pathological findings, there were 8750 white blood cells per cubic millimeter and the differential count showed 75 per cent polymorphonuclear leucocytes.

Fluoroscopic examination of the gastro-intestinal tract revealed the fundus of the stomach in the pelvis and contained 15 per cent residue at the five hour examination. The duodenal cap was spastic but showed no constant deformity. The colon was also in a clonic state. *On fluoroscopic examination, the appendix was visible,* tender, and fixed behind the cecum. Plates confirmed these findings except that the appendix was not visualized because of its retrocecal position.

Operation March 31, 1930. Through a right rectus incision exploration of the upper abdomen revealed no abnormality of the gall bladder, liver, or stomach. A freely movable cecum covered by a Jacksonian membrane was delivered. The appendix was curled around the lower posterior portion of the cecum and its midportion slightly kinked by moderately firm fibrous adhesions extending from the cecum to the mesoappendix. Similar adhesions extended from the distal 2 cm. of the appendix as a pyramid-shaped structure with its base formed by a 2 by 3 cm. area of a high loop of the ileum. Between these thin bands were 2 cyst-like structures arising from the end of appendix, the largest of which was 1.5 cm. in diameter and the other about 8 mm. across. In dividing the connective tissue strands the cysts were broken discharging a thick, jelly-like, colloid liquid. After the adhesions were freed the slightly bleeding denuded area of the ileum was sutured over. The mesoappendix, after the adhesions were cut, was clamped and ligated. The appendiceal base was crushed, including part of the cecum, ligated and dropped. The pelvic organs were free from any abnormal changes. No jelly-like material was found free in the abdomen.

Pathologically, the appendix measured 6.5 cm. from its base to the tip and the diameter varied from 1 cm. across the base and 1.2 cm. at the tip which was slightly bulbous. On the antimesenteric border there was a bulbous swelling 2 cm. in the long axis of the organ, protruding as high as 9 mm. above the serosa, and having a transverse diameter of 7 mm. The terminal portion of this tumefaction had its distal end 2 cm. from the tip of the appendix. The surface was slightly lobulated and of a gray glistening color which was interrupted by very thin hyperemic fibrous adhesions. The serous surface of the appendix and mesoappendix were the site of similar adhesions.

Transverse sections through the appendix at various levels between the base and the proximal portion of swelling on the antimesenteric border revealed a patent lumen, 2 to 4 mm. in diameter, which was free from any material of any nature. Surrounding the cavity the mucosa was of normal appearance, and below it were 7 to 8 large discrete and occasionally confluent lymph follicles. In the submucosa were focal patches of fibrosis and spaces filled by fat. The circular muscle fibers were occasionally encroached upon by these and here and there were scattered lymphocytes. The layer of longitudinal muscle fibers were of normal histological appearance. The serosa in places presented a vacuolated appearance in which were small accumulations of basophilic homogeneous material. About these spaces was a fibrillar network enmeshed in which were many varying sized capillaries about which were occasional small accumulations of lymphocytes.

Transverse sections through the site of the tumefaction revealed the picture seen in Figure 1, demonstrating a narrow, then wider tract penetrating the wall on the antimesenteric side of the appendix which leads into a space filled by material that gave positive microchemical reactions for mucin. The intact portion of the appendix was lined by columnar epithelium which, only here and there, dipped down a slight distance. The submucosa was markedly thickened by dense layers of eosinophilic leucocytes, polymorphonuclear leucocytes, lymphocytes, and a thin fibrillar connective tissue network, and a few isolated glands. Irregular and poorly defined masses of lymphocytes and extensive hyalinized areas resulted in marked thickening of the submucosa. The circular muscle fibers were separated in places by similar inflammatory cells as seen immediately below the epithelium lining the cavity. The longitudinal muscle layer was moderately thickened and below the serosa was an isolated group of lymphocytes. The lumen at this level contained no mucus.

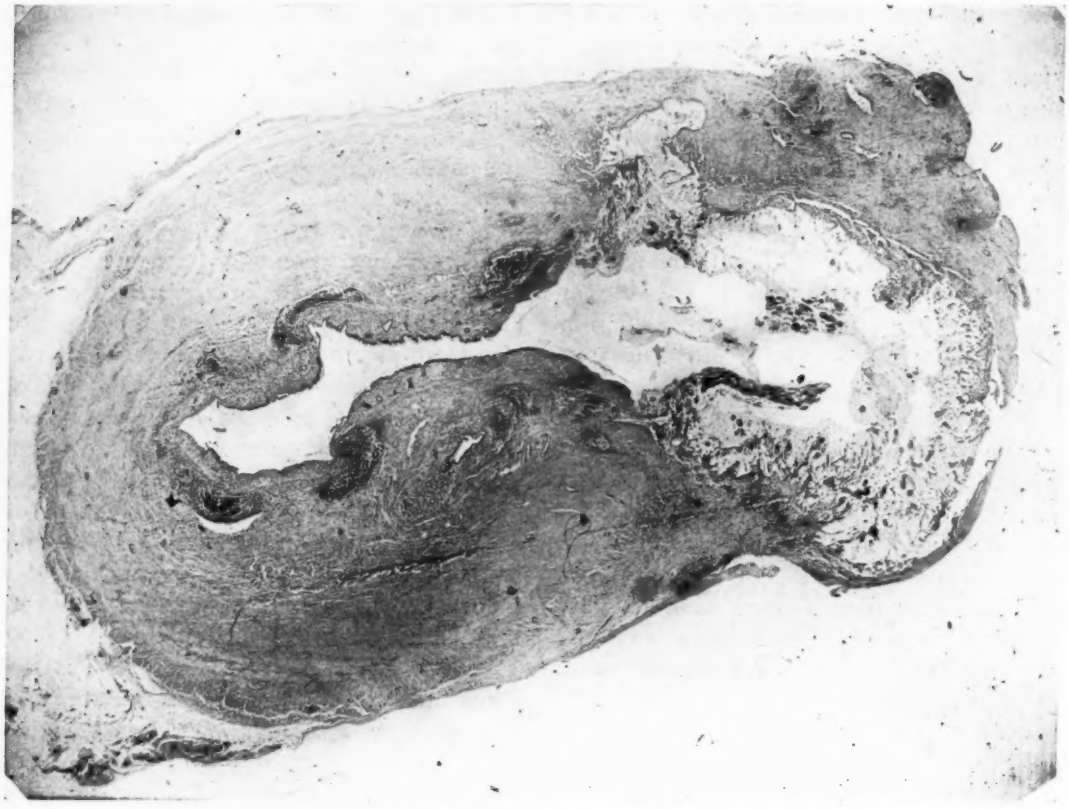

Fig. 1. Antimesenteric appendiceal mural defect leading into mucocele, contents of which give positive microchemical reactions for mucin.

At the site of the defect, or hiatus, the epithelium extended well out to line the proximal portion of the mucin-filled cavity, and below this was the same inflammatory exudate as seen in the intact portion. The muscular walls extended part way out to make up part of the wall of the cyst; however, in these portions considerable hyalinization and fragmentation had taken place. The cavity of the cyst proper was filled by homogeneous pale blue staining material (hemotoxylin and eosin) which was interrupted by varying sized and shaped masses of lymphocytes and occasional plasma cells and erythrocytes which were most abundant on the appendiceal side of the cavity, next to the jutting out muscular layers of the appendix (see Fig. 2). The wall of the distal portion of the cavity was composed of markedly thinned out fibers containing elongated slightly pycnotic nuclei.

Discussion. By correlation of the history and the pathological findings we are led to assume that the patient suffered gradual

perforation of the appendiceal wall over a period of seven months, with accompanying subacute exacerbations, with referred pain into the upper abdomen and gastric symptoms. The site of perforation is typical of mucoceles following an inflammatory process rather than a congenital defect. In the latter state the defect is attributed to apertures in the wall about the vessels entering on the mesenteric side. The other theories favoring a congenital pathogenesis apply as well to an inflammatory process, in that separation of the muscle fibers and weakness of the musculature do occur with an inflammatory process. As to whether an ulceration or an intramural abscess was present with the onset or in the course of the disease, it is impossible to say at this stage of the condition.

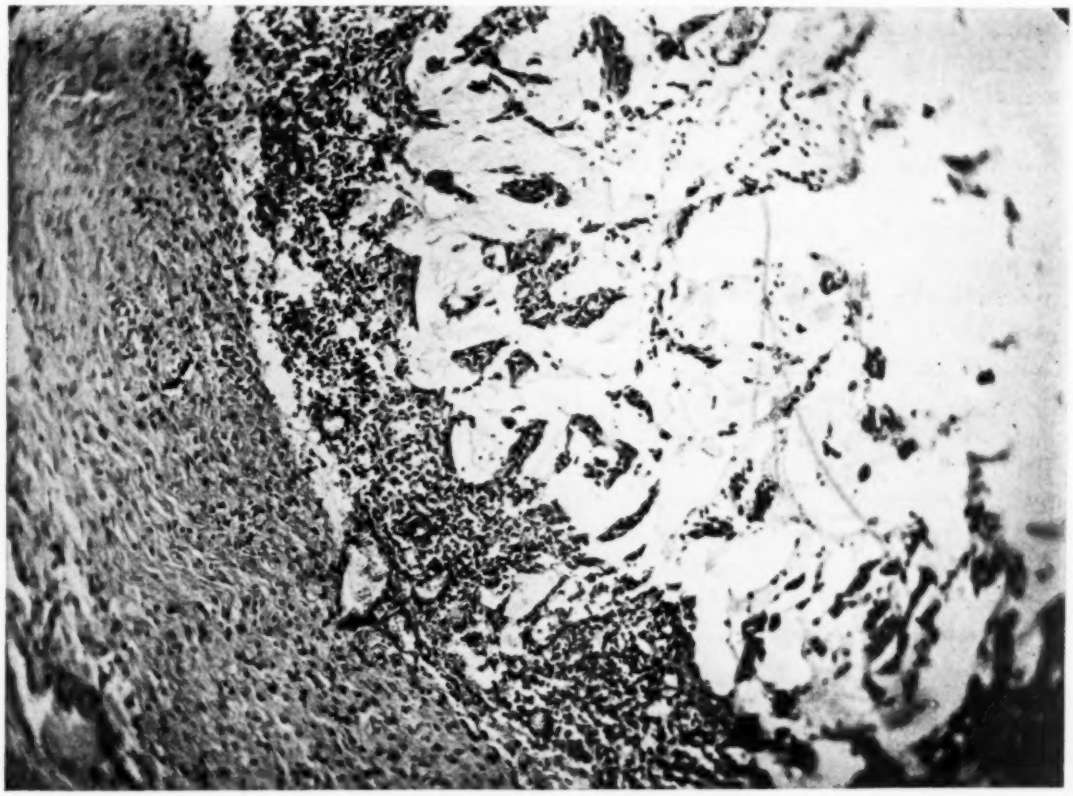

Fig. 2. Wall of mucocele close to appendix. Cavity contains mucin and groups of lymphocytes and plasma cells latter forming a layer internal to connective-tissue wall.

If the lumen of the proximal portion of the appendix is occluded it is reasonable to assume that the secretory pressure of the residual intact mucosa is sufficient to result in a diffuse or localized dilatation of the organ. In our patient, it is possible that the appendix may have been occluded at some time earlier in the process. However, this is hard to believe because intermittent occluding spasm of the appendix would be almost impossible in view of the amount of fibrosis of the wall and the changes in the muscular layers. Also, the specimen shows no evidences of mucus in the lumen proximal to the mucocele indicating that the fluid had not regurgitated into the cecum from the possible previously distended portion. In addition the degree of submucosal fibrosis distal to the base would tend to prevent dilatation of this region.

It has been assumed that the contents of a mucocele is sterile as otherwise gangrene or empyema of the appendix would result. In our patient the contents of the appendix and the cavity of the mucocele had access to the cecal portion of the large

bowel and therefore the ordinary intestinal bacterial flora could have reached the peritoneal cavity, by way of the gap in the lumen, and resulted in generalized peritonitis. The absence of peritonitis is hard to explain unless the mucosa or mucus had bactericidal properties or the quantity of infected material was of such a small amount that the peritoneum could overcome this infection.

The end-result at times has been the typical picture of pseudomyxoma peritonei in which the entire abdominal cavity becomes filled by this thick material. This condition has been attributed to the secretory property of the peritoneum or to actively secreting epithelial cells freed from their primary seat and continuing their function of producing mucus. In no other form of peritoneal irritation does the abdominal cavity lining respond in this manner. Histological examination of the jelly-like nodules attached to the peritoneum shows that they are superimposed on this structure rather than part of it so that this explanation is hardly tenable. Although examination of this fluid has, in some instances, revealed the presence of isolated and occasionally short rows of epithelial cells after very careful and extensive searching, certainly this small number of infrequently found cells could give rise to no such enormous accumulation of intra-abdominal mucoid material.

The theory has also been advanced that the fluid is not a product of epithelial secretion but rather a mucoid degeneration of newly formed connective tissue at the site of the mucocele. This may explain the presence of a small amount but it is hardly possible that this can account for the tremendous amounts seen in some instances.

It seems more logical to conclude that the primary focus is in the secreting epithelium of the ovary, enterocystoma, or appendix. For if these offending foci are removed, providing that they are not associated with a carcinomatous process, or if not too extensive, and keeping in mind the possibility of their arising from two sources, then the process usually stops. This is well exemplified in the 2 cases reported by Ries. Both patients have recently been examined and show no evidences of reaccumulation of the fluid. The first, in 1907, had a head-sized pseudomucinous cystoma of the ovary and an appendix, the site of a mucocele, removed. Large quantities of colloid material escaped when the peritoneum was opened and as much of it as possible were scooped out of the abdominal cavity. The second patient operated on in 1923 had the omentum covered by colloid which was found to be escaping from a large cystic tumor of the right ovary and a similar but smaller and intact mass was found in the left ovary and the cul de sac was filled by jelly-like material.

CONCLUSIONS

From roentgenological and pathological evidence permanent stenosis of the appendix is not necessary for the formation of a mucocele.

Pathogenic organisms may have access to a mucocele but do not necessarily result in peritonitis, empyema, or gangrene of the organ.

The bactericidal properties of the mucus or pseudomucinous material and the epithelium of the appendix deserve further study.

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INTRA-ABDOMINAL USE OF EPINEPHRINE IN HYPOTENSION DURING SPINAL ANESTHESIA*

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THE fall of blood pressure during spinal anesthesia is caused by: (1) Dilatation of the splanchnic vessels, and (2) An abrupt block of the secretory impulses to the suprarenal medulla, with a resulting oligoadrenalemia.

The vasoconstrictors of the splanchnic vessels and the secretory nerves of the suprarenal medulla are both sympathetic fibers. They have a medullated preganglionic part, emerging from the spinal cord with the anterior motor roots of the spinal nerves, pass the paravertebral ganglia with the white rami communicantes and run into the collateral semilunar or solar and the superior mesenteric ganglia. Here they make a synaptic connection with the non-medullated postganglionic fibers which run to the blood vessels and abdominal viscera. From the sixth lower dorsal and from the upper third and fourth lumbar segments collected preganglionic sympathetic fibers form the major and minor splanchnic nerves.

In spinal anesthesia the subarachnoid part of the preganglionic sympathetic fibers are blocked with the anterior motor roots and no stimulus can reach either the synapse in the collateral ganglia or the arborization of the postganglionic fibers. The vessels of the stomach, the intestines, the kidneys and spleen are cut off from the vasomotor impulses and become dilated. At the same time all the secretory stimuli to the suprarenal medulla are blocked and the adrenalin output of these organs is stopped or greatly reduced. A drop in blood pressure results from these combined effects of the sympathetic block. The fact that various individuals possess splanchnic vessels of different capacities may account for a variation in blood pressure drop with the same height of anesthesia. The presence of accessory chromaffin tissues in the organismus may cause a still further variation.

(Preanesthetic hypertensions of various origins are excluded from these considerations.)

A sudden fall in blood pressure is no longer regarded with the old anxiety. Most surgeons disregard it entirely and many do not bother with blood pressure readings at all. However three factors should be considered in the matter of anesthesia:

1. A proper blood supply to the heart chambers.

2. That the pulmonary vessels have sufficient circulation to oxygenize the blood.

3. A satisfactory blood supply to the brain so that the vital centers of the medulla oblongata can be adequately nourished.

As long as these three factors are properly maintained there need be no alarm. In the Trendelenburg position the dreaded consequences of an empty heart, insufficient oxygenation of the blood and of cerebral anemia are eliminated. In the Trendelenburg position sufficient blood will be drained by the vena cava inferior to supply the right auricle of the heart, and if the anesthesia proceeds to the third or second dorsal segment it will not be unfavorable to heart action. The heart receives its sympathetic accelerator fibers chiefly from these segments and if they are affected the cardio-depressor vagus fibers invariably will produce slower contractions with a prolonged diastole. A longer diastole means better filling of the chambers and a longer rest for the myo-

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cardium, which will be followed by a more powerful systole. This cannot be interpreted as evidence of insufficient cardiac function.

In considering these physiological facts and finding confirmation in many clinical observations, we cannot blame surgeons for being optimistic, or of being indifferent toward temporary hypotension in spinal anesthesia.

The experimental work coupled with many clinical observations by Koster[1] shows clearly that the fear of respiratory paralysis in spinal anesthesia is caused chiefly by false physiological interpretations and by misunderstanding. He proved that all of these symptoms are caused by secondary cerebral anemia. Recently Saklad[2] in his paper disproved the shock producing reputation of spinal anesthesia.

All seem to agree on one point, namely, that the Trendelenburg position is the best method of overcoming difficulties which may arise from spinal anesthesia. I am of the same opinion but with one exception: that the Trendelenburg position is reliable only as long as the patient is in the dorsal position. In the dorsal position the vena cava inferior occupies the deepest part of the abdominal cavity. According to the law of gravity it will drain the blood from the dilated splanchnic vessels. But if in spinal anesthesia, we place the patient in the ventral position, with head lowered, as is sometimes necessary for certain operations, we may be surprised by disagreeable incidents.

In this position the vena cava inferior will occupy the highest plane of the abdominal cavity and the drainage of blood from its branches is not so facilitated by gravity, and consequently it receives and transmits less blood to the right auricle. Then also there is interference with thoracic respiratory movements and, as we know, the rôle of the chest is very important when, in expansion, it "sucks" up the blood from the large veins. Respiratory embarrassment with cerebral anemia may suddenly appear, and in this case the old reliable Trendelenburg position will not help unless the patient is turned on his back. This should be done before the patient's condition is too grave, and artificial respiration should be started at once.

We confess that the Trendelenburg position is far more useful than any procedure or medication at our disposal in combating the undesirable by-effects of spinal anesthesia.

With our present drug armamentarium we are far less successful. Let us suppose a patient under spinal anesthesia and in Trendelenburg position and that we cannot obtain the blood pressure at all. The pulse rate is increasing: it is flying, and we would like to correct this condition. What can we do? We have two drugs at our disposal to avert or correct the fall of blood pressure. These are ephedrine and epinephrine.

EPHEDRINE

Preanesthetic injections of ephedrine are strongly advocated by many and ridiculed by others. Ephedrine stimulates the vasomotor center, the heart action and peripherally acts directly on the muscle tissue instead of on the myoneural junction of the sympathetic fibers.[1] In many surgeons' minds there is no doubt about the value of ephedrine injections, ten to twenty-five minutes before spinal anesthesia is administered. Falls of blood pressure are not so frequent and alarming. Nevertheless we see them in spite of ephedrine. During anesthesia a second injection may raise the blood pressure, or it may not. Labat, Saklad and others have protested against repeated ephedrine injections during spinal anesthesia on the grounds that ephedrine does not produce a vasocontraction in the

[1] Koster, H. Spinal anaesthesia for head, neck and thorax: Relation to respiratory paralysis in spinal anaesthesia for the head, neck and thorax. *Surg., Gynec. and Obst.*, 149: 617, 1929.

[2] Saklad, M. Studies in spinal anesthesia. Am. J. Surg., 11: 452, 1931.

[1] De Edds and Butt. Further evidences of non-sympathomimetic action of ephedrine. *Proc. Soc. Exper. Biol. & Med.*, 24: 800, 1927.

splanchnic vessels but does so in the rest of the vascular system, with a resulting pooling of more blood in the already dilated splanchnic system. As an illustration of the prevailing opinion among investigators I quote Saklad who gave an excellent analysis on the basis of experimental and clinical studies of Chen, Bloedorn-Dickens, Size, Blalock, Rudolph-Graham, Phelps and himself. He found that spinal anesthesia administered to dogs after the injection of ephedrine caused vasodilatation. Administration of ephedrine under spinal anesthesia produced no vasoconstriction in the splanchnic vessels. He summarizes:

> We have in ephedrine a powerful drug which through its vasoconstricting action and by its cardiac stimulation is capable of raising blood pressure. It is an agent, which is contraindicated in cases of cardiac insufficiency. It may cause ventricular extrasystoles and in cases of chronic myocarditis its use is apt to cause a fall in blood pressure rather than a rise. It should not be given in small doses in the presence of low blood pressure. In large doses it puts too heavy a load on the heart. It is of no value in severe shock. Its dosage must not be repeated. [In his clinical observations he admits that] the administration of ephedrine does not allow the pressure to fall to the extent that would occur if it were not used.

He found the average drop of blood pressure to be 38 mm. in cases where ephedrine was used before the spinal and 60 mm. average fall where no ephedrine was used.

I have a series of 150 spinal anesthesia cases in which spinocaine was used and in these I administered 0.025 to 0.05 cg. of ephedrine subcutaneously prior to the spinal injection. In these unselected cases the anesthesia reached the costal margin in 87 per cent and the average fall of blood pressure was 24.5 mm. In 112 cases in which the preoperative systolic blood pressure did not exceed 140 mm. the average fall was only 17.2 mm. Among the cases which received ephedrine injections during the established anesthesia for the purpose of checking blood pressure drops, 37 per cent did not respond with a rise. The remaining number showed an average increase of 15 mm. within fifteen minutes. The majority of these cases showed an increased pulse rate after the ephedrine injections.

EPINEPHRINE

The action of this drug is identical with the function of the sympathetic nervous system. Its point of attack appears to be in the muscular or glandular tissues innervated by the sympathetic. One of its important actions (among many others) is the vasoconstricting effect on the splanchnic vessels. The general opinion among research workers is, that adrenalin is released slowly by the suprarenal medulla and it is proved that this output is stopped or greatly reduced by section of the splanchnic nerve supply. In spinal anesthesia there may be a complete block of the secretory fibers which supply the suprarenal medulla. We are justified in supposing, therefore, that because of this interference in normal adrenalin output, oligoadrenalemia results. The extract of suprarenal medulla either from natural sources or its synthetic equivalents, is used in 1–1000 solution to combat hypotension. The solution is administered subcutaneously, intramuscularly or, in emergencies, intravenously. It is reliable, prompt and powerful when given in time and into the blood stream. The blood pressure rises and the ventricular contractions are pronounced. However, in a few minutes its beneficient effects are over and herein lies its weakness. It is too easily oxydized and destroyed. Subcutaneous and intramuscular injections produce a longer effect but the slow absorption when so used would, in an emergency, prove too costly. Repeated injections of epinephrine in cases with heart lesions or with arteriosclerosis are not desirable.

Epinephrine solutions, even very dilute, still exert a pronounced vasoconstrictor action when locally applied. In abdominal operations we can take advantage of this factor and as we have easy access to the

splanchnic region we have a method of dealing with undesired vasodilatation. In an emergency during abdominal operation, where there is a disappearance of blood pressure combined with a weak and flying pulse and eventual respiratory embarrassment, I recommend the following mode of epinephrine medication:

The patient receives immediately an intravenous injection of 0.5 c.c. of 1:1000 epinephrine solution. Simultaneously from 8 to 15 drops of sterile epinephrine solution, diluted with 100 c.c. of sterile normal saline solution are poured into the peritoneal cavity. The intravenous injection acts promptly and the intra-abdominally administered solution will maintain the effect by its prolonged vasoconstrictor action over the dilated splanchnic vessel area. This method works instantly and for from fifteen to sixty minutes there is a definite vasoconstrictor action just at the point at which the blood stagnation is greatest, Sterile Erlenmeyer flasks with prepared normal saline solution should be kept in readiness. The epinephrine solution is made in a few seconds and it can be used any time between opening and closing of the peritoneal cavity, should the condition of the patient require this medication.

CONCLUSIONS

1. In analyzing the innervation and function of the suprarenal gland and the condition begot through spinal anesthesia it is justifiable to believe that oligoadrenalemia is also a factor in the development of hypotension.

2. The Trendelenburg position is the most effective method of combating an insufficient blood supply of the heart chambers, insufficient external respiration and cerebral anemia; but precaution should be used in the ventral Trendelenburg position.

3. During abdominal operations under spinal anesthesia and in the presence of alarming circulatory disturbances, the intra-abdominal administration of 8 to 15 drops of epinephrine in 100 c.c. of normal saline solution is a useful method to support the simultaneous injection of intravenous epinephrine solution. This method has a limited field. In pus cases it should be avoided, or if used, proper precautions must be taken not to disseminate infection.

THE DETMOLD METHOD OF CONTROLLING INOPERABLE HEMORRHAGE

A FORGOTTEN, BUT OCCASIONALLY INVALUABLE, PROCEDURE*

J. F. BALDWIN, M.D.
COLUMBUS, OHIO

DR. WILLIAM L. DETMOLD (1808–1894), Professor of Military Surgery and Hygiene during the Civil War in the College of Physicians and Surgeons of New York, in a paper published in the *American Medical Times*, of January 3, 1863, discussed gunshot wounds of the lungs, and suggested a treatment to check hemorrhage which was later referred to in Holmes' "System of Surgery."[1] It should be remembered that at this time the recognized procedure to control profuse hemorrhage was liberal phlebotomy, this treatment being based on the idea that after large loss of blood, the blood pressure being diminished and the clotting element of the blood increased, nature would check the bleeding.

Detmold's suggestion, which, though presented especially for controlling hemorrhage from wounds involving the lungs, applies as well to all hemorrhages beyond immediate reach, was published nearly seventy years ago and reads as follows:

> Now, as a general rule, wounded men do not bear well depletion; in most cases the soldier's constitution has already been weakened by fatigue, exposure, and camp diet, and the wounded men want all the stamina to withstand the effects of prolonged and perhaps profuse suppuration in the hospitals, where in many cases the means are deficient for building up an enfeebled constitution. I would, therefore, strongly recommend to you a remedy, which, while it gives you all the advantages to be derived from copious and repeated venesections, is free from all its injurious results; this remedy consists in applying ligatures to the limbs by a circular pressure to the upper parts of the arms and thighs, tight enough to check superficial venous circulation without affecting the deeper arterial influx of blood. By this means, which is easily put into execution, you may temporarily withdraw any amount of blood from circulation without depriving the wounded of a single drop, the want of which might seriously affect his recovery; for when the momentary and imminent danger of life has ceased, that is, when the pulmonary hemorrhage has stopped, you gradually loosen the ligatures and allow the blood which you have retained for a while harmlessly in the extremities to re-enter circulation.

My attention was called to Detmold's method through Holmes' "System of Surgery." My first case was an ideal one; a woman, sixty years of age, had been for some hours vomiting large quantities of blood; she was breathing with difficulty; was cold and nearly pulseless. Considering her age, I assumed she was suffering from cancer of the stomach. I applied bandages to the extremities, close to the trunk as directed by Detmold, and was delighted to find the hemorrhage promptly controlled. After waiting a reasonable time I released the constrictions, thus restoring the blood to the circulation. She made a prompt recovery and belied my presumptive diagnosis by living nearly twenty years with no recurrence of hemorrhage.

Not long ago a case of fatal gastric hemorrhage was reported at the staff meeting of one of our local hospitals; the autopsy showed that the hemorrhage came from the duodenum. The case was reported by the Professor of Medicine in our local medical college, a graduate of the Johns Hopkins school. He had promptly used the ordinary means for checking hemorrhage but without avail. When I suggested to him in the discussion the Detmold method he heartily approved of it, but said he had never heard of it.

A similar fatality has been reported from the Massachusetts General Hospital.[2] In this case the conditions present were apparently identical with those in the personal case reported here; my patient,

[1] Vol. 1, p. 455, 1881.

[2] *New England J. Med.*, 206: 294, Feb. 11, 1932.

* Submitted for publication March 4, 1932.

however, being a woman sixty years old, while this patient was a man of sixty-three years. The usual means of treatment were followed in this case, including, but perhaps ill-advisedly, transfusion, but apparently no one had any knowledge of the Detmold treatment, and during the later discussion of the case not one of the seven staff physicians who took part mentioned this treatment or apparently had any knowledge of it. The patient entered the hospital "forty-eight hours" after the primary hemorrhage and the diagnosis was promptly made; but he was allowed to drift along and "on the eighth day he died!" The autopsy showed plainly that the Detmold treatment would almost certainly have permitted a later operative procedure.

Three physicians of Brooklyn, N. Y., report[3] two fatal cases of ulcer of the stomach with autopsy, with certain advice as to operative intervention in such cases, but with no suggestion as to control of hemorrhage until the patient could be gotten into condition for comparatively safe operative procedures. Their only recommendation seemed to be the standard one of morphine, with perhaps transfusions.

Max Einhorn, of New York, in discussing the "Management of Acute Hemorrhages in Peptic Ulcers,"[4] advises in the treatment "perfect rest abed, ice bag over the stomach, injecting thromboplastin or blood serum, and alleviating pain by sedatives." He reports in detail two cases, but not a word about the possible need of the Detmold treatment.

During the last two years I have taken many opportunities to question hospital interns and other recent graduates as to the Detmold method, but no one of them had ever heard of it. I have also looked through a considerable number of works on surgery, but have found no mention of it.

R. H. M. Dawbarn (1860–1915)[5] describes what he calls "sequestration anemia," which he secures by bandaging the extremities as recommended by Detmold, but he recommends this merely as a preparation for an operation in which he anticipates much hemorrhage. Horsley[6] also refers to "sequestration anemia," but like Dawbarn makes no mention whatever of that procedure to check bleeding. He cautions against the use of it, however, because in some cases he thinks it increases shock. Welch, however, states[7] very positively that "a stationary column of blood included in an artery or vein between two carefully applied aseptic ligatures within the living body may remain fluid for weeks."

This treatment should unquestionably be instituted in all cases of hemorrhage in which direct treatment to reach the bleeding point is impossible, and would include, therefore, large hemorrhages from the lungs, stomach and bowels, and possibly, under some rare circumstances, could even be used, at least for temporary purposes, in uterine hemorrhages.

Both Dawbarn and Horsley warn against leaving the constricting bandages on too long, but advise releasing them from time to time at perhaps fifteen to thirty minute intervals; probably releasing, however, one at a time so as to maintain the efficiency of the "sequestration."

How many times I have used the Detmold method for thus stopping bleeding I do not know, but so far as I can recall I have never had any unfortunate results but have quite uniformly accomplished the desired end.

The bandages recommended by Detmold could probably be more satisfactorily substituted by rubber tubing or ordinary tourniquets, but bandages are always obtainable.

They have a saying in Texas, we are told, to the effect that "a man seldom needs a pistol, but when he does he needs it mighty bad." The same is true with sequestration in certain cases of inoperable hemorrhage, and every surgeon should certainly keep in mind this method.

[3] Am. J. Surg., 15: 304, 1932.

[4] *Med. J. & Rec.*, 135: 219, March 2, 1932.

[5] Keen's System of Surgery, Phila., Saunders, 1921, Vol. 5, p. 192.

[6] Operative Surgery, Ed. 3, St. Louis, Mosby, 1928.

[7] *Johns Hopkins Press*, 1: 47, 1900.

LYMPHANGIOMA OF THE RECTUM*

A. J. Chisholm, M.D., and Philip Hillkowitz, M.D.

DENVER, COL.

As no mention is made of this type of tumor in this particular location in any of the textbooks on diseases of the rectum, a report of the following case with the pathologic findings will be of interest to both the proctologist and pathologist.

A cursory review of the literature shows but a solitary brief allusion to such a condition by Kaufmann[1] in his textbook on Special Pathology, who cites a case of lymphangioma recti in his own experience. It was a cystic lymphangioma the size of a walnut in a male patient, situated in the submucosa of the anterior wall.

CASE REPORT

Mrs. P. F., housewife, aged thirty-eight, came to the office July 8, 1927. She gave a past history of the usual diseases of childhood, of an attack of typhoid fever in 1914, of influenza in 1918. An operation for appendicitis and bilateral salpingitis had been performed on her in 1923.

She began to have pain and discomfort in the rectum about two years prior to her first visit with a sensation of burning and fullness following stool. She reported that considerable blood was discharged with a very uncomfortable feeling. These symptoms were constant up to the time of the first call.

Rectal examination showed a few skin tabs around the anus, also several small internal hemorrhoids. A mass, the size of a walnut, was felt in the right posterior quadrant extending up to the rectal pouch. The tactile impression was like that of a thrombosed vessel. The mass bled on palpation.

Proctosigmoidoscopic examination revealed a small tumor with the mucosa ulcerated, localized in the right posterior quadrant of the rectum; otherwise, the rectum and sigmoidal mucosa were normal. A tentative diagnosis of carcinoma of the rectum was made and operation advised. Three weeks later, under sacral anesthesia, the mass was completely excised. The patient made an uneventful recovery. Three months after the operation a proctologic examination revealed a normal condition of the rectum. Since that time, now almost four years, there has been no complaint of any rectal disturbance.

Fig. 1. Lymphangioma of rectum. ×7.

Pathologist's Report (Dr. Philip Hillkowitz): The tissue removed at operation measures 1 × 0.5 × 0.5 cm. and is of moderately firm consistency. It is lined on one side by mucous membrane.

Sections reveal a normal mucosa with glands lined by a single layer of columnar cells showing no atypical proliferation. In the submucosa and extending across the entire section is a fibrous stroma presenting a honeycomb appearance. There are numerous round spaces lined by a single layer of endothelial cells.

[1] Kaufmann, E. Lehrbuch der Speziellen Pathologischen Anatomie. 9th and 10th Ed., Vol. 1, p. 750, Berlin, 1931.

* Submitted for publication October 9, 1931.

Many arterioles and dilated veins are seen in the supporting stroma. The spaces vary somewhat in diameter but the majority measure 130 microns. Occasionally there is a tear in a narrow wall separating two adjacent spaces and a larger interstice results. In following down the mucosa in the anal direction, the surface lining abruptly becomes the stratified squamous epithelium. Here too under the epithelial layer we find the honeycomb arrangement as described above.

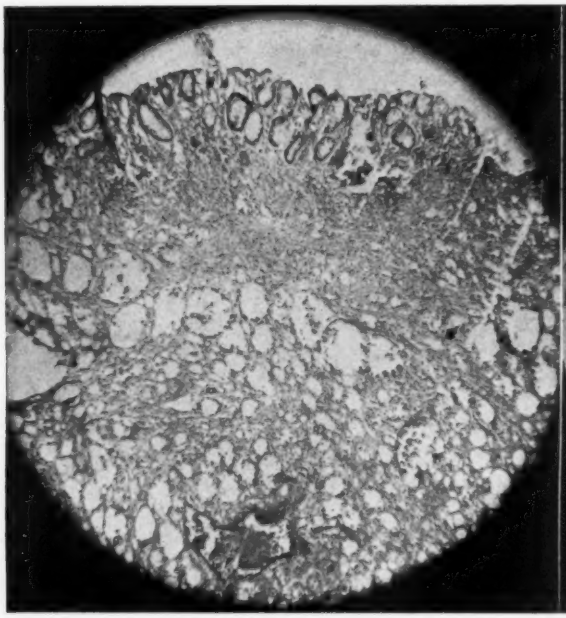

FIG. 2. Lymphangioma of rectum. ×33.

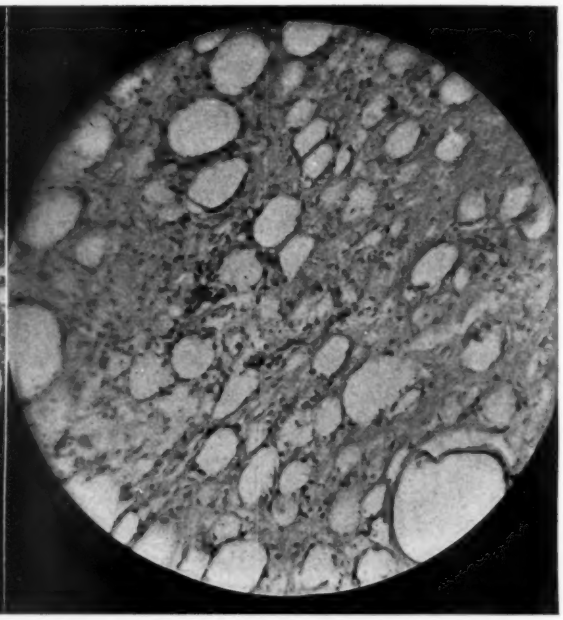

FIG. 3. Lymphangioma of rectum. ×100.

DISCUSSION

The question as to whether we are dealing with a true neoplasm or a lymphangiectasis is usually propounded in the investigation of lymphangiomata. Could the previous operative procedures have produced an interference with the outflow of lymph and given rise to dilatation of the existing lymphatics?

In our opinion such a possibility is remote and we incline to the more rational view of the neoplastic nature of the nodule.

SUMMARY

History and pathologic findings are given in a case of lymphangioma of the rectum in a woman of thirty-eight, simulating carcinoma by proctosigmoidoscopic examination, but whose true nature was revealed under the microscope. Symptoms disappeared following excision with maintenance of good health four years after operation.

ATTEMPTED SUICIDE BY USE OF GUN AND CARTRIDGE OF DIFFERENT CALIBER

REPORT OF A CASE*

J. ROBERT JOHNSON, M.D.

CHICAGO

MR. W. E. D., aged twenty-five, single, a periodic drinker with unmistakable evidence of emotional instability, on December 25, 1930, attempted suicide in the following manner: Having only a .32 caliber revolver cartridge and a .410 gauge (12 mm.) shotgun, he fitted the two together by first wrapping the cartridge in the tin-foil wrapper from a stick of chewing gum, then winding electrician's tape around this until it was large enough to fit tightly into the chamber of the gun. Next, he forced the shell with its wrappings into the chamber of the gun, made it ready to fire, and placed the butt on the floor and the muzzle against the left breast near the heart region. In stooping over to reach for and press the trigger with his right hand, he turned his body, lowering the right shoulder in order to increase his reach. Thus, at the moment the trigger was pressed, the barrel of the gun was almost parallel to the chest wall and directed to the left.

Examination. There was a short vertical slit, obviously torn, in the shirt; and a small round perforation in the underwear over the left breast. Starting over the third rib, 3 in. (7.6 cm.) to the left of the sternal margin was a short, wide abrasion, the left border of which was contiguous with a round perforation the size of a .32 caliber bullet. From the perforation, a subcutaneous tunneled wound ran 1½ in. (3.8 cm.) to the left between the third rib and skin; at the end lay the bullet, which was easily expressed. Powder marking was absent on skin and clothing. There was no evidence of rib or internal thoracic injury.

The bullet was of soft lead, .32 caliber, and was slightly flattened on one side. The exploded shell was found in the chamber of the gun, wrapped as described, and was removed. The gun barrel was seen to be heavily coated with powder granules and smelled of freshly burned gunpowder.

Treatment was ordinary and healing uneventful.

COMMENT

The interesting and unusual features of this case are: (1) The use of a cartridge of a small caliber in a larger caliber firearm is unusual and might lead to misinterpretation, especially by the police. If the gun were missing (as it was, for a time, in this case), the caliber of the bullet recovered and the lack of powder stains on the clothing or body would lead one to search for a .32 caliber revolver, fired at some distance by another person with, perhaps, criminal intent.

(2) The lack of powder burning is surprising, considering the very close range, and may be attributed to the almost total absorption of the small powder charge by the long barrel of the gun.

(3) The penetration of the missile was very slight because of the low muzzle velocity. There was great loss of velocity in the barrel of the gun because the force of the explosion escaped around as well as behind the bullet.

(4) Ballistic tests on the gun and bullet would be unsatisfactory. It would be difficult or impossible to duplicate the scratch marks on another bullet fired from the same gun.

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EDITORIALS

BIOPSY

BIOPSY as a diagnostic procedure is bound to become quite as essential where it is indicated in the routine examination of the human body as are blood cell counts and urinalysis. The latter, of course, are indicated in every case while biopsy is indicated only in the presence of a localized or generalized pathology.

In the past biopsy as a routine procedure in those cases in which it is indicated has been practiced more or less sporadically. However, during the past decade and perhaps more markedly during the past five years, biopsies have gained a foothold which has fully demonstrated their real worth.

Through the medium of biopsy a safe and certainly a more accurate diagnosis of the individual tissue pathology can be determined preoperatively. To be able to reach a definite decision, preoperatively, regarding the true pathology of any growth or tumefaction is a step in the right direction.

Again, it opens the way for a free discussion and wider field of consultation preoperatively when there arises a question as to the definite pathology of any area of the human body. The wider the field of investigation, the more liberal the views from multiple consultations. Greater cooperation in any case means not only a safer

judgment as to the method of procedure but also a more definitely successful outcome for the patient.

The fact that the patient is the most important individual in the hospital must never be overlooked. Anything within our power that will enhance the status of prognosis is certainly warranted and merits the support of all. This is just what biopsy does in any individual case.

All tumors and malignant growths deserve the serious consideration provided by biopsy. Through this medium the proper method of treatment can be determined. The study of the character of the individual cell means a great deal in moulding proper judgment upon which to give advice regarding the best method of procedure. Biopsy is always a great aid in finally determining whether the special growth in question warrants radical surgical intervention, instillation of radon seeds, application of mass doses of radium or superficial or deep *x*-ray therapy. It will also determine whether or not a combination of these methods of treatment will prove more advantageous. Biopsy will also determine whether or not it is advisable to use radium or *x*-ray therapy preoperatively, postoperatively or possibly both. In other words the universal adoption of biopsy as a routine in all tumor and malignant cases where possible seems the feasible thing to expect in the very near future.

The sooner the medical profession as a whole comes to realize fully the real worth of biopsy in cases of tumors and malignancy the sooner will there be established a standard upon which to proceed with greater accuracy. Through this medium a sounder basis for better judgment will be reached; a sounder basis for better judgment upon which to think and act in giving advice to patients in determining the outline of procedure preoperatively, operatively and postoperatively, in outlining to the patients the best care during the two or three year period following discharge from the hospital, in the prognosis regarding these highly important tumors and malignant cases.

It is not difficult to foresee the era in the teaching of medical science when biopsy will become a specialized part of the field of surgical pathology and will be so taken up in our medical schools. Biopsy offers a wide field in medical teaching as well as in medical practice in all its branches. It is bound to receive more emphasis in the future and the members of the medical profession should early grasp its true meaning and practical usefulness to the extent that all hospitals are required to make it part of their regular routine.

G. S. Foster, M.D.

ERRATUM

In the June issue of The American Journal of Surgery, vol. xvi, No. 3, page 415, column 2, line 15, through page 416, end of column 1, is a discussion by Dr. Clyde Wilson Collings of New York, on the paper by Dr. Theodore Davis of Greenville, S. C., on "Transurethral Correction of Prostatic Obstruction." By mistake, this discussion was not credited to Dr. Collings and appears as part of Dr. Kirwin's discussion.

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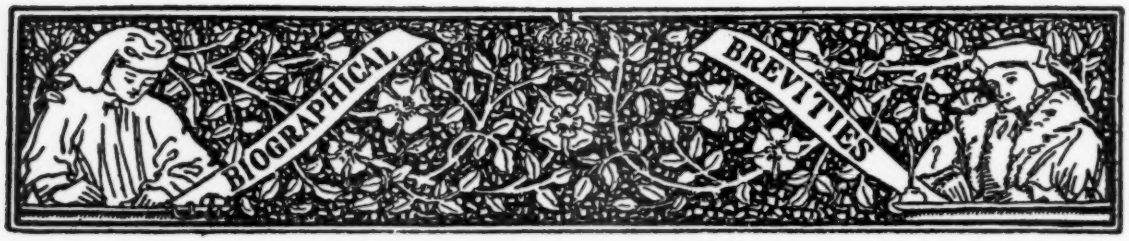


AMERICAN PHYSICIANS

JOHN FLEET*

JOHN FLEET is recognized historically for having been the first to receive a medical degree from Harvard, and for having been one of the founders of the Medical Improvement Society (1803), which society grew into the first Boston Medical Library (July 1, 1805).

He was born in Boston, April 29, 1766. His grandfather, an Englishman, upon settling in Boston, became engaged in printing and book-selling, and published a paper, *The Evening Post*, which we are informed was the best in New England, and "Fleet's Almanacks," which was an authority for many years. It is debatable if he was the original compiler of the "Mother Goose Melodies."

The grandson, the subject of this Biographical Brevity, graduated from Harvard College in 1785 at the age of nineteen years. Following his graduation he studied medicine in the Medical Institution of Harvard College. He dissected under Dr. John Warren. Prior to 1788 no medical degree had been granted by the College. In that year, however, John Fleet and George Holmes Hall applied for degrees. These were granted on July 16, but only after a heated professorial discussion. The degree was that of Bachelor of Medicine. As Fleet's name came first alphabetically, he was thus the first to receive a medical degree from Harvard.

Seven years later (1795) Fleet was the first to receive the degree of Doctor of Medicine from the College. To get the degree he passed an examination and presented a thesis in Latin, "Observationes ad Chirurgiae Operationes Pertinentes." His brother, Thomas, printed it. A copy of this is in the Boston Medical Library.

Fleet was the first assistant appointed in the Medical Department of Harvard College (assistant to Dr. John Warren, 1793).

His friends were the best medical men of Boston. He was one of the prominent founders of the Medical Improvement Society from which grew the Boston Medical Library. Fleet was the first librarian. In the beginning the books were kept at his house in Milk Street. Fleet, also, was librarian of the Massachusetts Medical Society from 1800 to 1813.

John Fleet never married. He died in Boston in his forty-seventh year, on January 4, 1813.

T. S. W.

*At the time of going to press a portrait of John Fleet had not been found. Should one come to light it will be included in a later issue. The Publishers will appreciate hearing from anyone who knows of such a portrait.

[From Fernelius' Universa Medicina, Geneva, 1679.]

BOOKSHELF BROWSING

DR. WILLY MEYER

ON February 25, 1932, just past midnight, Dr. Willy Meyer reached the end of the path of life. He died in the New York Academy of Medicine, in the room where the New York Surgical Society had just adjourned its meeting. It had always been his wish to die in harness, and this wish was fulfilled. After discussing a paper on "Cancer of the Breast," a subject which was one of the outstanding achievements of his life, he sat down with a severe heart attack, from which his many colleagues, friends, and associates who surrounded him could not save him. Death overtook him on that spot where some forty-five minutes before he had been calling out hope and encouragement to those cancer sufferers to whom, towards the end of his life, he had devoted himself.

On the banks of the River Weser, in Westphalia, Germany, lies the beautiful city of Minden. Here on July 24, 1858, Willy Meyer was born, the son of Abraham and Bertha (Simon) Meyer. He was the third of three sons. This triumvirate remained intimately united until Willy Meyer's death, the two older brothers, Julius and Theodore, surviving, and also living in America.

Besides these brothers, there are two younger sisters and one younger brother surviving.

Willy Meyer enjoyed a typical German education, attending and graduating from the Gymnasium in Minden, which he visited from 1867 until 1876. Here he had a thorough foundation in the classics, especially Latin and Greek, and also English. This knowledge of Latin and Greek stood him in good stead, as Prof. Busch, Chief of the Surgical Clinic in Bonn, under whom he later worked, insisted on conversing only in Latin in the presence of patients. "Ante patientem Latina lingua est."

In the spring of 1876 he entered the University of Bonn and studied there until the spring of 1878, when he transferred to the University of Erlangen for one year, only to return to Bonn in the spring of 1879, and to graduate as a Doctor of Medicine on August 7, 1880.

During the year he was in Erlangen he served the first six months of a year's voluntary military service in the Sixth Bavarian Jaeger Batallion of the German Army. The second six months, from April, 1881 until October, 1881, he spent as Volunteer Surgeon of the Fifteenth Infantry Regiment in Minden. He was honorably discharged from the German Army on February 21, 1884, as a Reserve Surgeon of the Seventh Hussars Regiment.

During his college days in Bonn, Willy Meyer joined the fraternity known as

"Allemania," and spent many happy days and hours in the fraternity group on the banks of the majestic Rhein and the beautiful nooks and corners of its many tributaries, where the fraternity members frequently made excursions. This instilled in him his great love of nature and the beauty of outdoor life.

During his student fraternity days, he fought two sabre duels and bore the scars of these on his chin and head. Of these, in typical German student fashion, he was very proud.

He greatly enjoyed reminiscing and frequently spoke of the happy student days, and the wonderful and profound influence which these days had upon his life.

His mother was anxious for her son to become a pianist, in which art he was very proficient, but during one summer vacation Dr. Abraham Jacobi visited Germany from America, and being an uncle by marriage, called upon the family in Minden. He asked the young student, Willy Meyer, to accompany him on a tour of some of the medical clinics as his personal secretary. This Willy Meyer did, and this experience instilled in him the desire to become a physician. He asked his parents' permission, which was granted. Thus his medical career began.

Graduating as a doctor in 1880 from Bonn, he joined the medical faculty of the University of Bonn in October, 1881, as assistant in the medical clinic. In this position he remained for two years, and then became first assistant in the clinic in October, 1883, remaining until the fall of 1884, when he emigrated to America. During this year he was assistant to Prof. Wilhelm Busch, Surgeon General of the German Army in 1870. Busch died suddenly. Prof. Madelung then became chief of the clinic, but some months later was transferred to Strassburg. Hereupon Friederich Trendelenburg became Professor of Surgery, and Willy Meyer was his first assistant, assisting him at all of his operations. A close and lifelong friendship ensued. Trendelenburg was so impressed by the ability of his young assistant that he honored him by asking him to publish the first account of what was later to be known throughout the medical world as the "Trendelenburg Posture."

Great advances were made in surgery during these years, and they left a lasting impression upon Willy Meyer and his entire future career. Germany rapidly introduced Sir Joseph Lister's principles of antiseptic surgery. The carbolic acid spray was used in the clinic at Bonn, and Willy Meyer often told the story of how Prof. Busch entered the amphitheatre one day, and, with a trembling voice, told his students that a young boy, the only child of a widow, had died of carbolic acid poisoning after an operation on the knee-joint performed under a carbolic acid spray.

Then with the development of bacteriology and Robert Koch's discovery of the tubercle bacilli, there developed the principles of sterilization of all instruments and operative materials. All surgical clinics rejoiced when the call appeared in literature, "Weg mit dem Spray" (Away with the spray).

Willy Meyer lived during and through this epoch-making period of surgery. It was fascinating to hear him tell of these interesting years.

An important fact and observation occurred in the service under Busch which had a great effect upon his later life, work, and thought. Prof. Busch had a patient with a bad ulcerating carcinoma of the breast. This patient developed erysipelas, had high fever, and was desperately ill for many weeks. She finally recovered, and when she was well of the erysipelas, the ulcerating cancer was also well. This thought and fact remained imprinted upon Willy Meyer's mind, and in the later years, from 1920 to 1930, when the dust of the busy road of life was fast falling on his head and he was turning gray and white, this fact appeared to help formulate the philosophy and thought behind the thesis as developed in his book "Cancer"—the acidosis produced by fever.

During his childhood days, he met Lilly Maass of New York, who visited Minden each summer. Their parents were life-long friends. This childhood friendship developed into love, and as a young doctor he became engaged to Lilly Maass in 1881. They were engaged four years, during which time his fiancée was in New York, only visiting Germany in the summer, and Willy Meyer was assistant in Bonn. It was on her account, and upon the advice of Abraham Jacobi, that Willy Meyer emigrated to America in the fall of 1884.

He settled in New York, and with his splendid German medical and surgical training and his burning enthusiasm for hard work, he gained a foothold in America. He was helped by many older friends, who recognized his unusual ability and fine character. He started in the general practice of medicine. In April, 1885, seven months after reaching the hospitable shores of our country, he was in a position to get married. A year later he specialized only in surgery.

Immediately after his arrival here, he was admitted to the German Dispensary as Assistant in the Surgical Department. From 1886 to 1893, he was Professor of Surgery at the Woman's Medical College, and all his life he had the keenest interest in the welfare of the College and in the New York Infirmary for Women and Children, where he was consulting surgeon. He gave a helping hand at all times to women doctors, for whom he held the highest esteem and greatest regard, and aided the cause of women in medicine to the last.

In 1886 he was appointed Attending Surgeon in the New York Skin and Cancer Hospital, now the Stuyvesant Square Hospital, where he remained active until 1902. Early in his career he performed extensive operations. Possessing a profound knowledge and understanding of the pathology of cancer, he performed the most radical operations for all malignant conditions.

In 1894 he published the principles underlying the technique he advised for the radical operation for cancer of the breast as he understood it. This type of operation, involving the removal of the breast, both pectoral muscles in their entirety, and complete axillary lymph-node dissection, bears his name. Even at present this operation in principle can not be improved upon. It was this subject that brought him just fame early in his career in America as a surgeon, and it was on this same subject that he delivered his last message to the medical and surgical world. His teachings on this subject and his influence are everlasting, and will continue on, and bring hope and health to countless patients in the future.

In 1886 he was appointed Attending Surgeon at the German Hospital, now the Lenox Hill Hospital. Here he developed his fame as a general surgeon. All his life he felt that it was important that a surgeon should be proficient in all departments of surgery. Being likewise appointed Attending Surgeon to the New York Post-Graduate Medical School and Hospital in 1887, and later Professor of Surgery, he introduced the German methods of teaching in his clinics. There was nothing in life that gave him more pleasure than to teach, to help others, to encourage young men, and to give a helping hand to everyone and anyone.

Whatever new developed in this country, or whatever new came from abroad, he immediately adopted it, and if from abroad he introduced it to America. He was a true pioneer in surgery. He was one of the first to introduce cystoscopy to America. With the electric cystoscope in 1896, he was the first surgeon in America to successfully perform the catheterization of the male ureters. He wrote many papers on the subject of genitourinary surgery.

In 1897 he was the first in America to perform Bottini's operation for hypertrophied prostate, on the basis of which the present modern improved method of electrocautery knife operation is performed for similar conditions.

He was also one of the first surgeons to introduce in America the modern methods

of gastrostomy and gastroenterostomy (1894 to 1896). In 1908 he published a book on Bier's hyperemic treatment in which he was a great believer.

In 1895 his eldest daughter, nine years old, developed an acute appendicitis. This was just at the time after McBurney in 1890 had begun to successfully operate upon appendicitis. She was operated upon on the third day of the third attack, and died on the third day after the operation, from peritonitis. Stunned and crushed by this irreparable loss, he began an intensive study of the subject, and wrote many papers. He stamped appendicitis a surgical disease, and urgently advised immediate operation during or immediately after the first attack.

Early in the twentieth century, from 1904 on, Willy Meyer devoted much time and interest to thoracic surgery. This part of the human body was still somewhat inaccessible to the general surgeon. The thought of entering an unknown field fascinated the energetic and fearless surgeon. When Prof. Sauerbruch came to America in 1907, he brought with him one of his negative chambers. He invited Willy Meyer to assist him in a thoracic operation upon a dog before a group of prominent surgeons. To Willy Meyer's joy and amazement, Prof. Sauerbruch said that he would leave this negative chamber in America for his use.

This spurred him on to intensive study, and despite his work in hospitals and private practice, he spent two afternoons a week at the Rockefeller Institute for Medical Research, experimenting on dogs. Quickly he recognized the inadequacy of the Sauerbruch chamber, and instigated his eldest brother, Julius Meyer, an engineer, to study the problem. The aim of these brothers was to develop a chamber in which, without moving the patient, chest operations could be performed either under negative or positive pressure, in order to find out which was best for the sick human being. This they accomplished, and built a negative chamber which was first used experimentally at the Rockefeller Institute and then transferred to the Thoracic Pavilion of the Lenox Hill Hospital, one of the only pavilions of its kind in the world. Here many operations were performed on humans. Despite many early failures and heartrending disappointments, Willy Meyer's indomitable enthusiasm and devotion to duty, and an unsurpassable courage, and infinite patience and perseverance soon led to happier results. He wrote continuously on thoracic surgery subjects, and helped to lay the foundation for thoracic surgery in America.

Quickly other surgeons took up the banner and aided in establishing this special field of surgery.

The Great World War rapidly advanced thoracic surgery, and showed that negative pressure was not essential in all cases.

In 1917 Willy Meyer called together all those surgeons especially interested in thoracic surgery, and he founded the American Association for Thoracic Surgery, which has grown and prospered, and is now flourishing in its fifteenth year.

He also founded the New York Society for Thoracic Surgery, which holds two meetings a year, at which thoracic subjects are discussed. This past year the *American Journal for Thoracic Surgery* has been successfully launched, which shows the marvelous development of this fascinating field of surgery, to which Willy Meyer gave so much of his life, energy, and thought.

When the United States entered the World War, Willy Meyer became Major in the Medical Reserve Corps. He was not called to active service, on account of his age, but one of his outstanding characteristics was his sincere, loyal, and splendid citizenship, his endless interest in city, state, national, and international politics. He spoke of Germany as his mother, and remained grateful to her for all that she gave him in his youth, and education. But the United States he spoke of as his bride, and he always maintained that even though born a

German, his first fealty, devotion, support and loyalty belonged to the bride, even though he still maintained his love for the mother, Germany. He was one hundred per cent an American. He maintained that science, as also music, should recognize no national boundaries; and following the War, he tried to help his stricken colleagues and friends abroad. He was interested always in every type of charity in which he felt that aid would be of value. He was a thirty-second degree Mason.

The welfare and good of the community, especially as to health, was deep-rooted in Willy Meyer. For over forty years he spent the summer at Lake George, at his simple but lovely home. For years he was chairman of the Sanitation Committee of the Lake George Association. He devoted much time, thought and energy towards the health and welfare of the country people. He prided himself in the knowledge that through the efforts of the Lake George Association and his committee, Lake George was the cleanest, purest, and most healthy body of inland water of its size and shore population.

In 1918 Willy Meyer, together with his older brother Julius Meyer as a literary assistant, began an intensive study of cancer literature. He followed all leads of all theories published, and after ten years of the profoundest kind of study and work, he came to the conclusion that cancer was a systemic disease. As age advanced, his active surgical work naturally diminished. But his burning desire to continue until the last, his lifelong devotion of service to mankind, and his active, marvelous young mind, not influenced in the least by advancing years, permitted him, in the solitude of his study, to think, to ponder, to philosophize. He canvassed, in his life's work, his active surgical and clinical experiences, and studied the literature of others, and with the memory of that memorable case of his youth in Bonn, when, under Busch, erysipelas cured the cancer, he formulated the theory as stated in his book published in 1931, "Cancer: Its Origin and Development: The Theory of Inoperable Cancer in the Light of a Systemic Conception of Malignancy."

He refused his help and services to no one who asked for them. A few weeks before his death he accepted an almost hopeless case of cancer of the rectum. One of our large hospitals for malignant disease had discharged the patient as hopeless—sent home to die, relieved of suffering only by morphine. Willy Meyer accepted the patient and operated upon her twice, the last time less than a week before his death. At seventy-three and a half years of age, his lifelong courage had not left him. He resected the sacrum, curetted away all the inoperable, fungating tumor, and then took a cherry-red cautery iron and ruthlessly burned and cauterized the entire base of the tumor. He then ordered treatment by the acidotic treatment and irradiation later on. A week later he died. As if it had been a memorial to his memory, the patient has clinically improved, and two months after the last operation, was able to leave the hospital in general excellent condition.

Willy Meyer's enthusiasm and courage must live on. Others must take up the reins. His theory must be proved right or wrong. In his broad-minded way, Willy Meyer thought that perhaps he was on the right track—no final solution or cure, but somewhere on the right track. It was his burning desire to live on, and he had made great research plans for the years to come, and had decided to devote his life to the cause of cancer itself.

God has willed it otherwise, but the name of Willy Meyer is indelibly imprinted on the pages of the legion of crusaders who work against the scourge of cancer.

As a husband and father, Willy Meyer's life was one of self-sacrifice, adoration, love, and devotion. His family life was a thing of beauty, a monument to a great man. He was married for forty-one years when his wife died three years ago. All their lives he showered her with devotion, attention, and self-sacrifice, which were

eloquently reflected in his wife's devotion and self-sacrifice for him.

He is survived by a daughter, Marjorie Meyer Flemming, and her husband; she gladdened his years by her proficiency in music, especially in singing. His only son, Herbert Willy Meyer, followed in his profession. They were intimately associated in practice, as brothers more than father and son, confided in one another, assisting one another in everything. His son was his House Surgeon in 1920 at the Lenox Hill Hospital and later his adjunct, until the father reached the age limit in 1923, and became consulting surgeon. It was a beautiful relationship.

His daughter-in-law and his two little grandchildren, five and three years old, were his joy and happiness. His life in the last years centered around them, and they helped to keep him young.

As a man, colleague, physician and friend, Willy Meyer's outstanding attributes were his kindliness, his gentleness, his sweetness of character. He was beloved by all who came under the spell of his influence and charm. Age, race, creed, or color made no difference to him. He reached out a helping hand to everyone, and rejoiced if there was anything he could do to help someone else, especially another colleague.

Willy Meyer was a real man, kindly, wise, generous to friend and foe, a constant stimulus to work and the joy of living. He leaves a heritage of honor, ability, energy, faith and charity. It seems weirdly and correctly fated that his life should have ended in the Academy of Medicine, and that he should have been permitted to leave the world in the medical atmosphere he so loved. H. W. M.

BOOK REVIEWS

THE DOCTOR EXPLAINS. By Ralph H. Major, N. Y., Alfred A. Knopf, 1931.

This book attempts to answer not only the questions which the patient puts to his physician, but also anticipates many which are never asked. An intelligent reading of this book by the laity would bring to the physician's office "better and more intelligent" patients. Dr. Major covers just the subjects that almost every physician would like to "get across" to his patients without having the time to do so. As the author ably points out, the time is past when the physician can accomplish his ends by shrouding his science in mystery. The patient of today wants (and is entitled) to know the whys and wherefores not only of his treatment but of the examinations he undergoes. In a remarkably small space and in a most interesting manner Dr. Major has succeeded in delivering this message. Were "best sellers" measured by the benefit derived by the readers from the reading thereof, "The Doctor Explains" would rank high in the lists. But unfortunately, anxious as people are for the information contained therein, it is to be feared that many will expect to get this information in concentrated form from their physician rather than by reading the book. For this reason we heartily recommend it to every physician. For while most physicians are fully able to discuss these things at medical meetings and among themselves, it is unfortunately true that many lack the ability of making things clear to patients, and a reading of Dr. Major's precepts will enable satisfying many a patient who might otherwise not get as clear an understanding as to "what it is all about." For your more intelligent clientele just prescribe this book "to be read in small doses"; to the others administer the prescription yourself, a little at a time.

STRATEGY IN HANDLING PEOPLE. By Ewing T. Webb and John J. B. Morgan, PH.D. Chicago, Boulton, Pierce & Co., 1931.

Probably no one has more need of an aptitude for "handling people" than the physician. And this for their own good even more than the physician's. Strange therefore, is it not, that in a book on this subject not one of the 27 chapters is devoted to doctors? However despite this fact there is no question but that every physician would profit by reading this book. It tells "how the other man does it," which is always interesting and instructive. The secrets of "masters of men" like Theodore Roosevelt, Ford and Schwab, are here revealed (or purported to be) and the reader will get many a tip from which he may well profit.

TECHNIK DER KNOCHENBRUCHBEHANDLUNG. By Dr. Lorenz Böhler. Ed. 3, Wien, Wilhelm Maudrich, 1932.

The volume before us may be considered "the last word" to date from the Böhler Clinic. We have here 670 pages as against 194 in the previous edition and 1046 illustrations as against 281. The book goes into the minute details of Dr. Böhler's treatment of fractures and many points not previously clearly understood by a great many physicians are here clarified. While all of Dr. Böhler's methods cannot be adopted without modification in this country, his work on the treatment of fractures is worthy of study by everyone handling such cases. Dr. Böhler's apparatus is ingenious and much of it is unique.

A careful study of this new edition is recommended to everyone who has occasion to handle fracture cases.

MINOR SURGERY OF THE URINARY TRACT. By Hermon C. Bumpus, Jr., PH.B., M.D., M.S. (Urol.), F.A.C.S. With a Chapter on Caruncles by John L. Crenshaw, M.D. and a Chapter on Postoperative Care by Anson L. Clark, M.E., M.D. Phila., W. B. Saunders Co., 1932.

The following chapter headings will give an idea of the contents of this book which in 123 pages gives a concise résumé of the subject and considers the recent work on transurethral and endoscopic methods of treatment: General Considerations; Caruncle of Urethra; Stricture of the Urethra; Hypertrophy of the Prostate Gland; Carcinoma of the Prostate Gland; Contracture of the Neck of the Bladder; Stones in the Bladder; Tumors of the Bladder; Infec-

tions in the Bladder; Stones in the Ureter; Postoperative Care.

The book is too small to be of any real value to the specialist but it will serve as a splendid guide for the general practitioner who, after all, is the first one to see these cases.

ELECTROSURGERY. By Howard A. Kelly, M.D., LL.D., F.A.C.S., and Grant E. Ward, M.D., F.A.C.S. Phila., W. B. Saunders Co., 1932.

This book in seventeen chapters comprising 300 pages with 382 illustrations covers the subject of its title concisely and in an up-to-date manner. It is exactly the book that is needed for quick reference on this subject which is growing daily in importance. The illustrations are unusually well selected and of great merit. The authors have the faculty of saying much in a few words so that much more ground is covered than would be indicated by the small number of pages. Chapter 1 on "History" is a model of succinctness. While reporting their own work completely, the authors have not overlooked the work of others. The bibliography of 14 pages shows great care in its selection.

ELECTROTHERAPY AND THE ELEMENTS OF LIGHT THERAPY. By Richard Kovacs, M.D. Phila., Lea & Febiger, 1932.

There is undoubtedly a demand today for a succinct one-volume account of the present status of electrotherapy and this will be satisfied by this volume which covers the subject in authoritative textbook style. The specialist will require supplemental monographs on practically every chapter but for a rapid work of reference and for one who does not specialize in the subject, we know of no better work at the present time.

THE COMMONER NERVOUS DISEASES, For General Practitioners and Students. By Frederick J. Nattrass, M.D., F.R.C.P. Humphrey Milford, Oxford Univ. Press, 1931.

The idea of this book to give general practitioners a rapid insight into some of the commoner nervous diseases is a good one. Like all works of the kind, it has defects in that the selection of the commoner diseases is always a difficult matter and no two specialists are apt to make the same choice. In twenty chapters, making 218 pages, the author has done his work well and there are few non-specialists who will not profit by reading this work.

DISEASES OF THE CORONARY ARTERIES (MYOCARDITIS). By Don C. Sutton, M.S., M.D., and Harold Lueth, PH.D., M.D., St. Louis, C. V. Mosby Company, 1932.

A comprehensive monograph on this much discussed subject will be found a desirable addition to any medical library today and this book of 150 pages covers this subject in a complete and up-to-date manner. Based primarily on the authors' own experiences, it also shows a knowledge of the literature and due consideration is given thereto throughout the text. While cardiologists will probably differ with the authors on various minor points, it is felt that this is a perfectly safe book to recommend to the surgeon and general practitioner for quick reference on this subject.

THE HEART RATE. By Ernst P. Boas, M.D., and Ernst F. Goldschmidt, PH.D. Springfield, Ill., Charles C. Thomas, 1932.

According to the authors: "This monograph is based on continuous observations with the cardiotachometer, in each case extending over many hours, of the heart rates of 356 individuals. It consists of two sections: a study of the normal heart rate and its variations, and a study of the more important alterations in heart rate encountered in the clinic." There is a historical chapter, one on the cardiotachometer, a thorough discussion of the normal heart rate and five chapters on the variations during sleep and otherwise. The final chapters deal with the heart rate during anesthesia and operations and in disease. In the appendix, there are summary tables, a sample protocol, and graphs of the heart rate in a few of the experiments. All in all, this is a complete résumé of the work done on this subject and the book will be found invaluable by those using the cardiotachometer which, according to the authors, is now available in the open market.

The study of the heart rate has been of interest to physicians since the seventeenth century and this work undoubtedly represents a distinct advance in the study of the subject.

COLLECTED PAPERS OF THE MAYO CLINIC AND THE MAYO FOUNDATION. Edited by Mrs. Maud H. Mellish-Wilson and Richard M. Hewitt, M.A., M.D. Volume XXIII. Phila., W. B. Saunders Co., 1932.

All that need to be said about Volume XXIII of the famous "Mayo Papers" with its over 1200 pages of text matter and 265 illustrations is that it lives up to the standard of excellence set by the previous volumes. More than this need not be said of any work. It may not be amiss to point out as the editors do in the Preface, that 577 papers emanated from this Clinic in 1931. "Of these ninety-nine are reprinted in full, thirty-six are abridged, forty-three are abstracted, and of 399 only the titles are given." The careful editing of these annual volumes makes this set a perfectly splendid reference library for every practicing surgeon.

HUMAN CANCER, Etiological Factors; Precancerous Lesions; Growth; Spread; Symptoms; Diagnosis; Prognosis; Principles of Treatment. By Arthur Purdy Stout, M.D. Phila., Lea & Febiger, 1932.

In this work cancer is considered from the standpoint of the surgery and surgical pathology in particular. The subject is covered in a thoroughly comprehensive manner and it is about as satisfactory a single volume on this subject as can be found today. The subject of cancer, its diagnosis and treatment is today of such prime importance that any volume that treats the subject in conservative fashion is to be welcomed. Dr. Stout has succeeded in furnishing just that material which the surgeon needs for study and reference. Written in an unusually clear manner, the book is a splendid addition to our cancer literature. We leave it to the cancer specialist to differ with the author on various specific points. Taken all in all, it is one of the most satisfactory books on the subject that we have seen.

FRACTURES. By Meurice Sinclair, C.M.G., M.B., B.CH. (Edin.) with an Introduction by Sir Robert Jones, Bt., K.B.E., C.B., F.R.C.S., Modern Surgical Monographs, Edited by G. Gordon Taylor, O.B.E., M.A., F.R.C.S. London, Constable and Co., Ltd., 1932.

Any book on fractures with a preface by Sir Robert Jones is sure to command attention. The book before us has 550 pages and 337 illustrations, mostly *x*-rays. The present status of the treatment of fractures in England is well presented in this volume. We miss reference to the method of treatment of Dr. Böhler of Vienna and to many American methods which evidently have not yet been adopted in England. For supplementary reading, this book may be heartily recommended to the American surgeon.

MANIPULATIVE SURGERY. By A. S. Blundell Bankart, M.A., M.CH. (Cantab.), F.R.C.S. Modern Surgical Monographs, Edited by G. Gordon Taylor, O.B.E., M.A., F.R.C.S. London, Constable and Co., Ltd., 1932.

According to the author: "It is only in recent years that the ancient practice of manipulation, or moving joints for therapeutic purposes, has been dignified by the title of 'manipulative surgery.'"

The author has succeeded in covering the subject completely and has made a step towards obtaining for the subject the more dignified position which he claims for it. In a little over 150 pages, Dr. Bankart treats his subject with a remarkable degree of thoroughness. Regarding Osteopathy he says: "Osteopathy is a typical American money-making stunt. It is based upon an imaginary displacement or subluxation of one of the lateral joints between two adjacent vertebrae." This is a statement with which most American surgeons will find no difficulty in concurring. A book of this kind has been needed and a great part of its value consists in its showing that surgeons are not against the use of manipulation where necessary while avoiding at the same time making thereof the cure-all which is claimed for it by exploiters.

SURGERY WITH SPECIAL REFERENCE TO PODIATRY. By Edward Adams, M.D. Burlington, Vt., International Journal of Surgery Co., 1932.

There is undoubtedly a field for a book of this kind but it is to be doubted whether this volume will fill the bill. The volume is an enlarged revision of a book written by the author in 1917. The peculiar construction of the book is perhaps best expressed by the author's statement that the book has been written and compiled primarily for the student

of podiatry. He also hopes that the industrial surgeon will find much of interest and value therein. Like so many volumes that try to satisfy several classes of readers, the work falls between two stools. While it is probable that it contains much that the chiropodist needs to know, it is doubtful whether it offers much to the practicing surgeon. There is a glossary of twenty pages in which it is frankly stated that the definitions have been taken from Stedman's Dictionary. It would seem better to advise having Stedman's Dictionary at hand rather than to take selections therefrom. The typography is different from any other book with which the reviewer is acquainted and not particularly attractive.

Modern Treatment Anaesthesia. By W. Stanley Sykes, M.A., M.B. (Cantab.), D.P.H. (Leeds), M.R.C.S. With a Section on Local Anaesthesia by P. J. Moir, M.C., M.B. (Glasgow), F.R.C.S. (Eng.). N. Y., W. W. Norton & Co., Inc., 1932.

According to the author, this book is written for the "occasional anaesthetist" and as such evidently is considered to have a place in England. It is not felt that a work of this kind would be of much value in this country but where a need is felt for a rapid outline, this work may fill the bill.

Approved Laboratory Technic, Clinical, Pathological, Bacteriological, Serological, Biochemical, Histological. Prepared under the Auspices of The American Society of Clinical Pathologists. By John A. Kolmer, M.D., DR. P. H., D.SC., LL.D. and Fred. Boerner, V.M.D. Assisted by C. Zent Garber, M.D. and Committees of The American Society of Clinical Pathologists Composed of Dr. J. H. Black, Dr. H. J. Corper, Dr. A. C. Foord, Dr. A. S. Giordano, Dr. F. W. Hartman, Dr. P. Hillkowitz, Dr. R. A. Keilty, Dr. R. A. Kilduffe, Dr. K. M. Lynch, Dr. A. H. Sanford and Dr. F. E. Sondern. N. Y., D. Appleton and Co., 1931.

This work, published under the auspices of The American Society of Clinical Pathologists, may be considered the standard work on laboratory technique in this country. The methods contained therein have been approved by this society which makes it as nearly official as is possible. The subject is thoroughly covered and the book is well arranged for quick reference. No laboratory, large or small, should be without it.

Diet Prescriptions, Compiled from Accepted Authorities. By Oscar Baer, M.D. Niagara Falls, N. Y., Arnson's Service and Supplies, 1932.

Dr. Baer has published in this work over seventy-five diet prescriptions which have been tried and found useful. The diets are more or less standardized and are available also in loose sheets for distribution to patients. For physicians with a large practice, they will be found valuable and handy. The pages are large enough to permit of notations making changes for individual cases. The average case is well covered by these diets. This is a thoroughly practical book for which we bespeak a large sale.

Surgical Clinics of North America (Lahey Clinic Number, Boston, Mass.) Volume XII, No. 3, Phila., 1932.

This number contains some 25 contributions from the Lahey Clinic in Boston. All of the important members of this Clinic have written special articles for this number and the volume lives up to the standard both of the publication and of the Clinic, which is high praise for any book.

Einführung in die Röntgentherapie chirurgischer Erkrankungen (Introduction to Roentgentherapy of Surgical Diseases). By Privatdozent Dr. Josef Palugyay. Vol. XVIII of Radiologische Praktika. Leipzig, Georg Thieme, 1931.

This monograph of one hundred pages is full of concentrated information as to the indications, mode of action, and results of roentgen therapy in surgical diseases. Surgical tuberculosis and malignant affections have constituted the chief fields of effort in *x*-ray therapy since the earliest days. In later years, especially through the efforts of the Author, large use has been made of roentgen therapy in specific and nonspecific inflammations. Little attention is paid to technique but careful directions are given as to the dosage, not only in percentage of "skin erythema dose" (HED)

but also in "roentgens." The quality of radiation desirable is also described under each recommendation. Thus, the work presents a great contrast with most previous publications on roentgen therapeutics. Indeed, it is only within the last two or three years that it has been possible to produce a text containing such definite instructions, which are perfectly intelligible to a radiologist who has given himself the necessary education in his specialty to permit him to employ the *x*-rays in therapeutics with modern precision.

Among the subjects for which roentgen-therapy is recommended are furunculosis, panaritia, less severe forms of phlegmon, lymphangitis, and even in pneumonia, peritonitis and sepsis. Heidenhain and Fried's series of 1500 cases of pyogenic infection treated by the *x*-rays, is one of the numerous series cited. Erysipelas should not be overlooked as a favorable case for roentgen therapy. Parotitis, orchitis, postoperative pneumonia, thrombophlebitis, and osteomyelitis are all given as fields for the use of this agent. Tuberculosis in its surgical forms is a fruitful field for good results in *x*-ray therapy. All of the foregoing utilizes about one-third of the book. The remaining two-thirds is devoted to the cancer question, full of such information and advice as is most desired by everyone having to deal with this important field of therapeutics.

The work is the product of the Second Division of the Surgical Clinic of the University of Vienna, directed by Prof. Hochenegg.

Allgemeine und Spezielle Elecktrochirurgie. By Dr. Med. Hans V. Seemen, mit einem Beitrag Elektrochirurgie der Geschwulste in Verbindung mit Strahlenbehandlung by Dr. Med. Otto Schurch. Berlin, Julius Springer, 1932.

The author of this book is the chief physician at the Lexer Clinic in Munich. Prof. Lexer in his Foreword says that he feels that this book gives a complete résumé of electrosurgery and above all that it gives a clear picture of its present stand, particularly at the Lexer Clinic. No exception can be taken to this statement and this work is undoubtedly one of the most practical that has been published to date. The illustrations, of which there are over 300, are unusually well selected and many of them represent the best in modern color printing. Without claiming too much for the electro-surgical knife, the author has succeeded in presenting a remarkably fair picture of its present position in surgery and the supplement by Dr. Schurch on "Electrosurgery of Tumors in Connection with X-ray and Radium Therapy" is a splendid monograph in itself. The bibliography of over 30 pages presents an interesting picture of this most modern surgical procedure and it is interesting to note that English and American literature is thoroughly considered. All in all, the book is the most up-to-date and practical treatise on the subject known to us.

Elektrische Verletzungen, Klinik und Histopathologie. By Dr. Stefan Jellinek. Leipzig, Johann Ambrosius Barth, 1932.

This work on electrical injuries is based upon thirty years' experience in electropathology. It is probable that Dr. Jellinek has a larger experience in this line than any other man. It is divided into the following chapters: 1. Electro-trauma; 2. Subjective Perceptions of the Electrocuted and Objective Immediate Symptoms; 3. External Changes; 4. Severe External Injuries; 5. Injuries of the Internal Organs; 6. Affections of the Nervous System; 7. Pathologic Anatomy; 8. Histopathology; 9. Therapy: a. Problem of Resuscitation, b. Conservative Measures, c. Benzine Therapy, d. Active Injuries (indications and counterindications). It will be seen from this that the subject is thoroughly and completely covered and it may be said that the text bears out the promise of the Table of Contents. The illustrations, many of which are colored, are well selected and beautifully reproduced. All in all, this work is probably the most thorough and complete reference book on the subject extant. It is likely to remain the standard for many years to come.

Leitfaden der Kosmetik, für die Arztliche Praxis. By Prof. Dr. A. Buschke, Dr. Alfred Joseph and Dr. Werner Birkenfeld. Berlin, Walter De Gruyter & Co., 1932.

As its title indicates, this is a primer of both medical and surgical cosmetics and as such fulfills its purpose. It replaces no other work but will serve well as an introduction to the subject for the physician who is not specializing therein. An English translation of this work should be well worth while.

CHIRURGISCHE INDIKATIONEN, für Arzte und Studierende. Erster(allgemeiner) Theil. By Prof. Dr. Kark Reschke. Berlin, F. C. W. Vogel, 1932.

In 357 pages, 30 of which are devoted to bibliography and index, the subject of surgical indications is treated entirely from the German standpoint and, as such, this book has a very definite function. Not all of the indications for operations would be blindly accepted in this country but the reverse would also be the case were the book written in this country. It is well however to have available this book giving the German standpoint of today. All the references in the bibliography are to German literature. This volume is to be followed by another, treating of the "special" organs and conditions.

BOOKS RECEIVED

All books received by THE AMERICAN JOURNAL OF SURGERY are listed in this column as soon as possible after their receipt and this must be considered as adequate acknowledgement. Books that the Editor considers of special interest to our readers will be reviewed in a later issue.

ANUARIO DENTAL, 1929–1930. Madrid, 1931.

ARTHRITIS DEFORMANS UND CHRONISCHE GELENKKRANKHEITEN. By Hans Burckhardt. Stuttgart, Ferninand Enke, 1932.

DICKDARMSCHLEIMHAUT (DIE), IHRE NORMALE UND PATHOLOGISCHE FUNKTION IM ROENTGENBILDE. By Werner Knothe. Leipsig, Georg Thieme, 1932.

ENGLISH-SPEAKING STUDENTS OF MEDICINE AT THE UNIVERSITY OF LEYDEN. By R. W. Innes Smith. London, Oliver and Boyd, 1932.

GESUNDE (DIE) UND KRANKE WIRBELSÄULE IM RÖNTGENBILD. By Georg Schmorl. Leipsig, Georg Thieme, 1932.

GROSSE ARZTE. By Henry E. Sigerist. Munchen, J. F. Lehmanns, 1932.

JAHRHUNDERT (DAS) DER STRAHLEN. By Josef Rosenthal. Leipsig, Georg Thieme, 1930.

MEDICAL ANNUAL, 1932. Bristol, Eng., John Wright and Sons, 1932.

RHEUMATOID ARTHRITIS AND ITS TREATMENT. By Vincent Coates and Leo Delecati. London, H. K. Lewis, 1931.

SIGN (THE) OF BABINSKI. A STUDY OF THE EVOLUTION OF CORTICAL DOMINANCE IN PRIMATES. By John F. Fulton and Allen D. Keller. Springfield, Ill., Charles C. Thomas, 1932.

UNSPEZIFISCHEN CHRONISCHEN ERKRANKUNGEN (DIE) DER WIRBELSAULE. By Hans Burckhardt. Stuttgart, Ferinand Enke, 1932.

PERIPHERAL NERVE INJURIES

LEWIS J. POLLOCK, M.D., AND LOYAL DAVIS, M.D.

EIGHTH INSTALLMENT

CONTENTS

[This Number]

Chapter		Page
		Vol. XVII
XXIV.	The Ulnar Nerve	301
XXV.	Combined Median and Ulnar Nerve Lesions	333

[Previously Issued]

		Vol. XV
I.	The Incidence of Peripheral Nerve Injuries	179
II.	Examination: History; General Examination	183
III.	Examination (*Cont.*): Motion	185
IV.	Examination (*Cont.*): Subjective Sensory Disturbances	390
V.	Examination (*Cont.*): Causalgia	395
VI.	Examination (*Cont.*): Objective Sensory Disturbances	403
VII.	Examination (*Cont.*): Nerve Overlap	411
VIII.	Examination (*Cont.*): Vasomotor, Trophic and Secretory Disturbances	573
IX.	Examination (*Cont.*): Electrical Examination	581
X.	Examination (*Cont.*): Reflexes	589
XI.	Diagnosis: Differential Diagnosis	592
XII.	Diagnosis (*Cont.*): Signs of Severe Nerve Injury	599
XIII.	Diagnosis (*Cont.*): Recovery of Function	605
XIV.	Development and Structure of the Peripheral Nervous System	620
		Vol. XVI
XV.	Pathology of Peripheral Nerve Lesions	141
XVI.	Histopathology of Nerve Degeneration and Regeneration	156
XVII.	Indications for Surgical Treatment	173
XVIII.	Methods of Nerve Repair	181
XIX.	Surgical Technique of Nerve Operations	353
XX.	Postoperative Treatment	377
XXI.	Treatment of Irreparable Nerve Injuries	550
XXII.	The Radial Nerve	566
		Vol. XVII
XXIII.	The Median Nerve	139

Chapter XXIV

THE ULNAR NERVE

In civil life the ulnar nerve may be injured as a result of pressure during sleep, especially during an alcoholic debauch. However, this occurs less frequently than does the same injury to the radial nerve. Similarly, it may be affected during the administration of a general anesthetic. Injuries and fractures and dislocations about the elbow, and callus formation, frequently produce ulnar paralysis. At times the paralysis occurs many years after the initial injury and is known as tardy or late ulnar palsy. Cases of this kind have been known to occur forty-four years after the initial injury. Dislocation and fracture of the humerus, arthritis of the cervical spine, cervical ribs, tumors and other diseases in the supraclavicular region produce paralysis of the ulnar as well as the median nerve. Occupational paralysis may often be found among watchmakers, cigar makers, metal workers, telephone operators and tailors. Occasionally the ulnar nerve alone may be affected by lead poisoning. It may be the seat of a mononeuritis following typhus, malaria or influenza. It is seldom the seat of a tumor.

In the War, injuries to the ulnar nerve were very frequent. The statistics vary, inasmuch as in some instances injuries to the brachial plexus involving the ulnar nerve were classified as ulnar nerve, or combined ulnar and median nerve injuries. In some instances the injuries constituted 18.5 per cent (Wexberg); in others, 16.7 per cent (Lehmann) of the total number of peripheral nerve injuries.

Motor Symptoms

Section of the ulnar nerve should produce inability to flex the proximal or distal phalanges of the ring and little fingers, to abduct or adduct the fingers, to extend the second and distal phalanges of any of the fingers, to adduct the thumb,

to contract the flexor carpi ulnaris and to abduct or oppose the little finger.

When paralyzed, the appearance of the hand is quite char-

FIG. 186. Typical clawed-hand appearance in ulnar nerve paralysis.

acteristic (Fig. 186). First, there is noticed an atrophy which at times is very marked in the first dorsal interosseous space and to a lesser degree in the other spaces. Second, there is noticed a claw hand which results from the unopposed action of the extensor communis digitorum. Sometimes clawing may be plainly seen in the little finger but can hardly be observed in the ring finger, yet at times the middle finger is clawed as

well. The hypothenar eminence shows considerable atrophy and palpation gives an impression of a hollow rather than an eminence. Atrophy of the adductor of the thumb may be

FIG. 187. Inability to oppose all of finger tips in ulnar nerve paralysis. Compare with normal hand on right.

made out at the inner part of the thenar eminence. The little finger stands off from the ring finger.

Despite such supplementary movements as will be described, the patient is unable to oppose the little finger to the thumb, to move the middle finger laterally the palm being flat on a table and the wrist immobilized, or to form a cone with the fingers and thumb (Fig. 187).

Paralysis of the flexor carpi ulnaris may be made out by inspection and palpation of the flexors of the wrist when the patient flexes the wrist against resistance. Paralysis of the flexor profundus of the little and ring fingers can be demonstrated by the imperfect flexion of the ring and little fingers in making a fist. The flexion produced at the metacarpophalangeal and second interphalangeal joints results from the influence exerted upon all segments of the finger when the flexor sub-

limis contracts. Flexion of the distal phalanges of these fingers often is practically nil.

Paralysis of the hypothenar muscles is shown by an in-

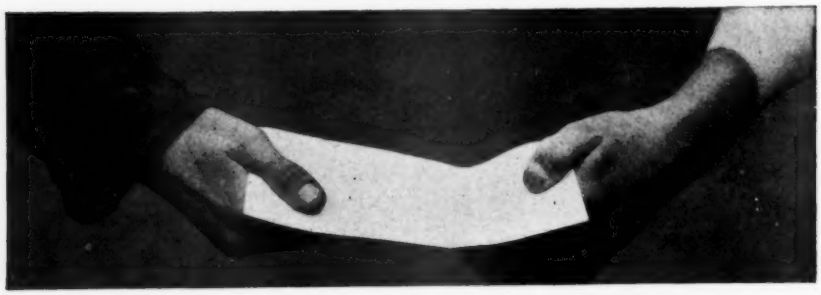


FIG. 188. Froment's newspaper sign in ulnar nerve paralysis. Note flexion of distal phalanx of thumb on right.

ability to flex the proximal phalanx of the little finger, the distal phalanges being extended. Paralysis of the interossei and of the inner two lumbricales produces the characteristic claw hand. Although all the interossei may be paralyzed, there is complete clawing only of the fourth and fifth fingers and sometimes of the middle finger. The reason for this is clear, inasmuch as the first two lumbricales which are supplied by the median nerve are unparalyzed. Extension of the distal phalanges is very feeble in the index and middle and more so in the ring and little fingers. Aside from supplementary movement, the lateral movements of adduction and abduction are lost in the middle, ring and often in the little finger.

Paralysis of the adductor pollicis and of the inner head of the flexor brevis pollicis produces defects in prehensile movement, attention to which has been drawn by Duchenne and by J. Froment. If the patient is asked to grasp any object between his thumb and index finger, such as a folded newspaper, and told to hold it tightly he vigorously flexes the second phalanx of the thumb and presses the tip awkwardly against the outer margin of the first phalanx of the index finger. This is Froment's "sign of the newspaper" (Fig. 188).

SUPPLEMENTARY MOVEMENTS: Flexion of the distal and proximal phalanges of the ring and little fingers is performed by the two inner tendons of the flexor profundus digitorum

FIG. 189. Extension of distal phalanges of index and middle fingers in ulnar nerve paralysis by supplementary muscle movement.

and the two inner lumbricales respectively. Imperfect flexion of those phalanges may result from the influence exerted on all segments when the flexor sublimis digitorum contracts. This is more marked in the little than in the ring finger. Slight flexion of the proximal phalanx of the ring finger may be obtained from the contraction of the flexor profundus digitorum pulling on the lumbrical muscles which have part of their origin from the tendon of the profundus. Although the interossei which extend the second and third phalanges of all fingers are paralyzed, inability to extend these phalanges in the index and middle finger is rare (Fig. 189). Bénisty attributes this to the preservation of the lumbricales, which she states extend the second and third phalanges, and the interossei. With this MacKenzie disagrees and he is inclined to believe that the dorsal interossei for the index and middle

fingers receive some of their nerve supply from the median. Besides this, he believes that with hyperextension of the proximal phalanx, there is an alteration in the line of pull of the interossei which become angular instead of straight and that an extended proximal phalanx forms a rigid dorsal support for the sublimis tendon, thus increasing its flexion pull. Therefore, paralysis of the lumbricales alone would produce at one time overaction of flexion of the second phalanx and a poor mechanical principle for extension of the distal phalanges. Other factors, however, enter into the production of extension of the second and third phalanges of the index and middle fingers. Duchenne, Bénisty and MacKenzie contend that the extensor communis digitorum does not produce extension of these phalanges. On the other hand, Beevor pointed out that although it was true that when the extensor digitorum was paralyzed the second and third phalanges could be extended, and when the interossei were paralyzed claw hand occurred and extension of the second and third phalanges was impossible, yet if in the latter case the third phalanges were passively flexed, the second and third phalanges could be extended. He says that it is probable that in claw hand the inability of the extensor digitorum to extend the terminal phalanges is due to its energy being expended on the first phalanges, which are not prevented from overextension by the lumbricales which are paralyzed.

The following factors enter into preservation of extension of the second and third phalanges: innervation of the first and second dorsal interossei by the median and passive extension of the second and third phalanges by flexion of the proximal phalanges, thereby shortening the interossei. If the interossei are paralyzed and the lumbricales preserved, the pull on the interossei is straight and not angular. Under these conditions, contraction of the extensor communis digitorum may exert a pull on the inert interossei and produce extension of the second and third phalanges. Some pull on these interossei may be exerted by the extensor communis digitorum even if these

conditions are absent, as may be seen in combined ulnar and median nerve lesions.

The fact that the extensor communis digitorum exerts a pull

FIG. 190. Adduction of thumb by extensor longus pollicis in ulnar palsy.

on the inert interossei does not mean that it is at all concerned with the normal extension of the second and third phalanges. This function normally may be the result of an entirely independent contraction of the interossei.

In adduction of the thumb, as pointed out by Duchenne, the extensor longus pollicis is the prime mover, and in ulnar nerve lesions it may supplant the loss of the adductor pollicis (Fig. 190).

Abduction of the fingers away from the midline may result from forced extension of the first phalanges. It is very marked in the index and little fingers (Fig. 191). Slight adduction results from flexion of the first phalanges. Both of these movements have been known for a long time. The reason for the preservation of lateral movements in the middle and index fingers is given by Bénisty as the preservation of the lumbricales, as well as the extensor movement of the first phalanges. As MacKenzie points out, the lumbricales are not

concerned with lateral movements of the fingers. The preservation of lateral movements of these two fingers is due, in addition to the extensor movements of the first phalanges, to a dual

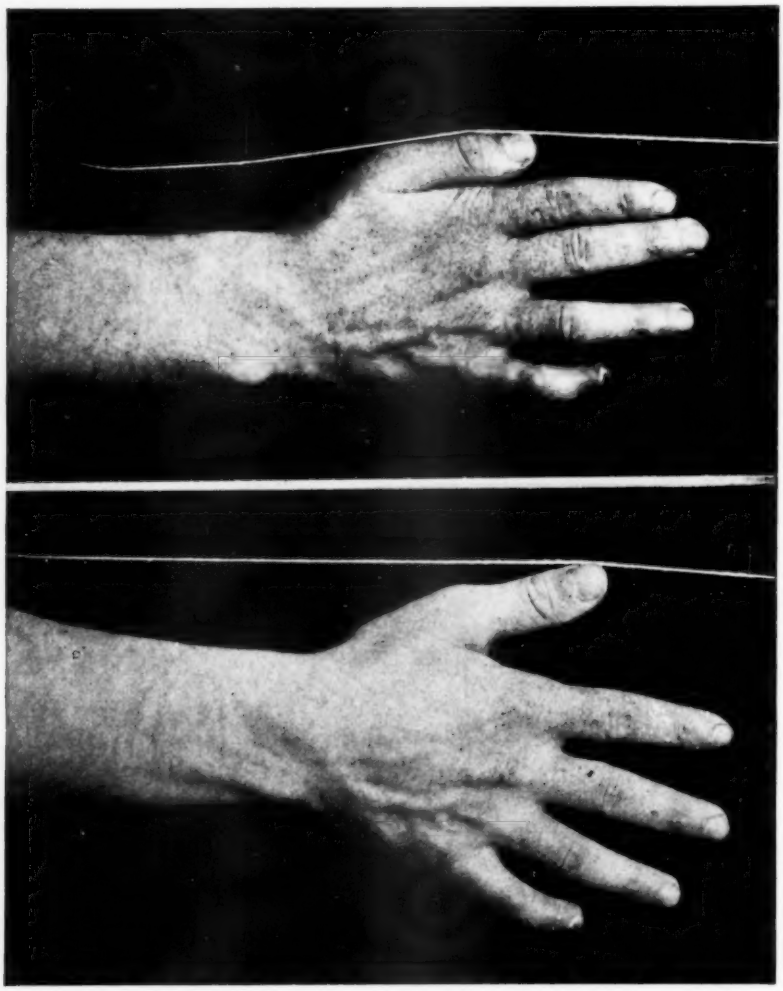


FIG. 191. Abduction of fingers by forced extension in ulnar poralysis.

nerve supply. It has been noted on a number of occasions that the first dorsal interosseus is partially preserved in complete ulnar section. Besides the abduction observed in forced extension of the first phalanx, abduction movement of the index finger can be produced by strong contraction of the abductor longus pollicis and extensor brevis pollicis. The first dorsal

interosseus, which has part of its origin on the metacarpal bone of the thumb, is pulled outward by extension of this bone and produces abduction of the index finger. When the hand is

FIG. 192. Adduction of index finger by strong contraction of extensor indicis in ulnar nerve paralysis.

abducted to the ulnar side, the tendon of the extensor indicis is so deflected that its contraction produces slight adduction of the index finger (Fig. 192).

SENSORY SYMPTOMS

In agreement with Bénisty, we have found that marked sensory loss exists even when the wound has not produced total section of the nerve. It is also marked in only partial lesions of the whole nerve. In a complete paralysis the sensory loss occupies the ulnar border of the palm, the palmar and dorsal surfaces of the little and ulnar half of the ring fingers. At times the whole ring finger and the ulnar half of the distal phalanges of the middle finger may also be involved. Stopford found that in 20 per cent of cases there were variations from the accepted sensory distribution of the ulnar nerve (Fig. 193).

The area of loss of pain and high degrees of heat and cold after overlap has been established is much smaller. Ordinarily, it may occupy the whole of the little finger. By superimposing the outlines of complete analgesia, the smallest area of analgesia in ulnar nerve lesions was found to occupy the palmar and dorsal surfaces of the little finger, extending over the

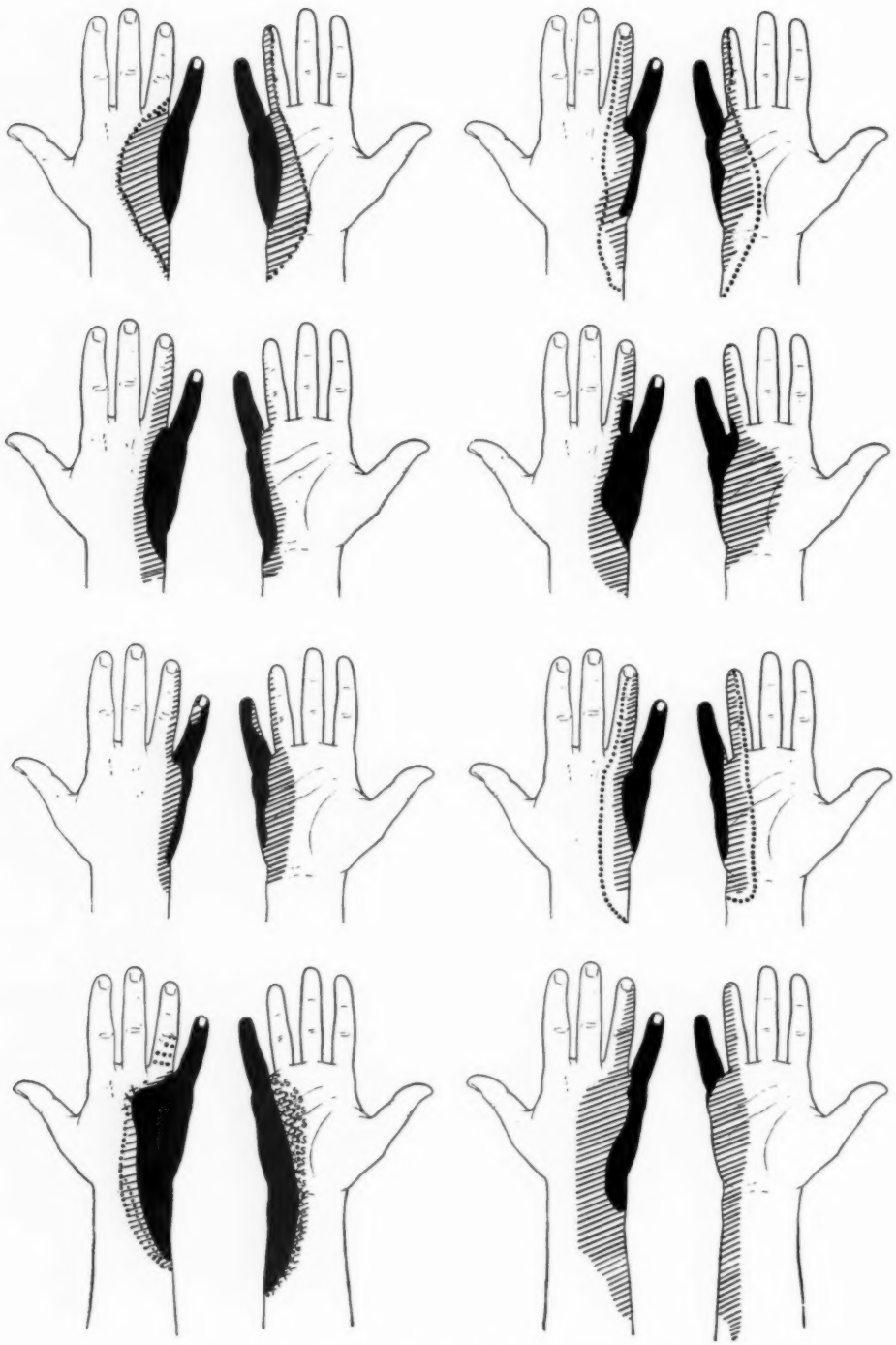


FIG. 193. Types of loss of sensation in ulnar nerve lesions.

[310]

dorsal surface of the hand in a triangular area over the fifth metacarpal bone to one-third of its length (Fig. 194). The area included between the borders of the accepted supply of the

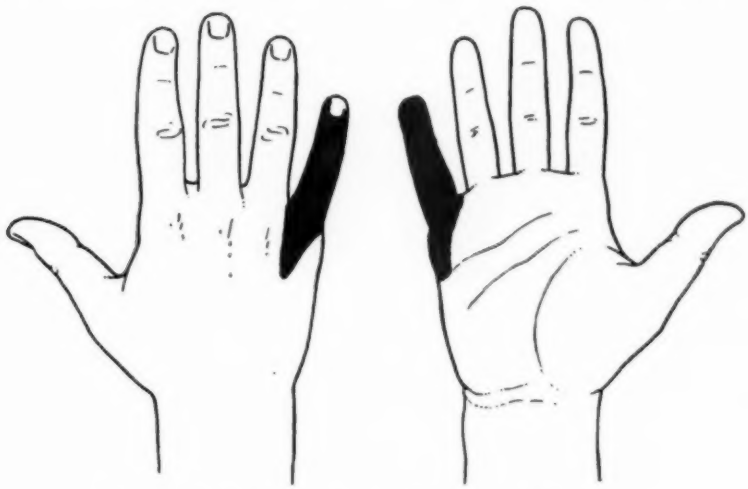


FIG. 194. Isolated supply to pain sense of ulnar nerve.

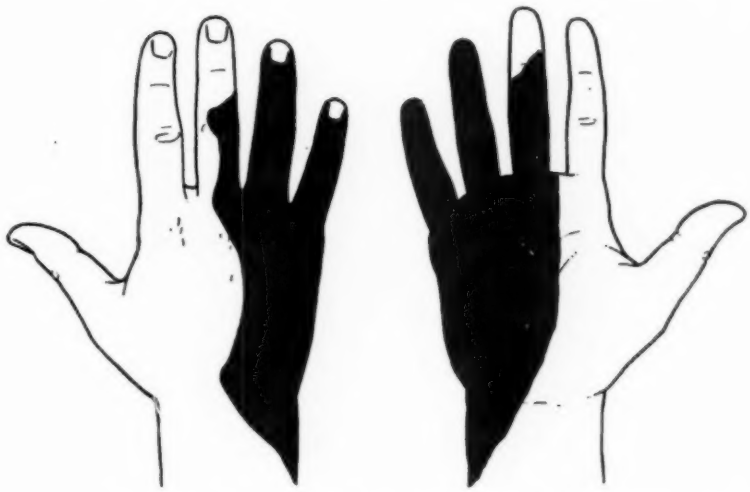


FIG. 195. Residual supply to pain sense of ulnar nerve.

ulnar nerve and the borders of this analgesia represents the possible supply of overlapping nerves to pain sense.

The area of total supply to pain of the ulnar nerve was obtained by the method of residual sensibility from a median

nerve lesion, a medial cutaneous nerve lesion and a combined median and radial nerve injury (Fig. 195). It occupies the ulnar portion of the palm to a line which is a continuation of the ulnar border of the abducted index finger, and the palmar surface of the fingers except the terminal phalanx and one-third of the ulnar part of the second phalanx of the middle finger. On the dorsal surface it occupies the ring, little and more than the ulnar half of the proximal one and one-half phalanges of the middle finger, and the dorsum of the hand to the radial border of the fourth metacarpal bone, ending proximally one inch above the wrist.

Insensibility to deep pressure or pinching is usually found only over the distal phalanx or distal two phalanges of the little finger. Bone sensibility and loss of sense of position may occur in high lesions of the nerve.

Vasomotor, Secretory, Trophic Changes

The skin over the little finger and hypothenar eminence is cold and often dry. Sometimes a purplish discoloration is seen. The skin may be thickened and the little finger nail deformed. Decalcification of the bones of the little finger may be noted. The marked muscle atrophy has already been described (Fig. 196). Ulcerations are often seen at the sites of burns produced by flicking off ashes from a cigarette or cigar (Fig. 197).

Level of the Lesion

The level of the lesion at times is the determining factor in a lesion which does not produce paralysis of all the muscles supplied by the ulnar nerve. When the lesion affects the nerve distal to a point one inch below the internal condyle of the humerus, the flexor carpi ulnaris is spared. Bénisty states that the most common type of partial paralysis is that produced by a wound in the axilla or arm, with paralysis of the interossei and hypothenar muscles and paresis of the flexor profundus and flexor carpi ulnaris.

FIG. 196. Marked muscle atrophy in ulnar nerve lesion.

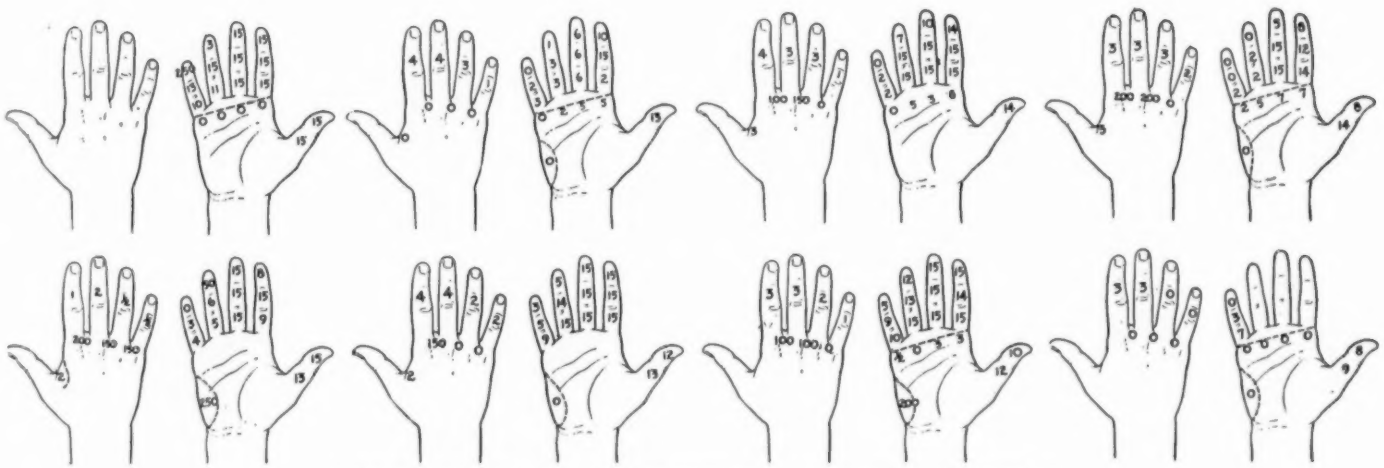
FIG. 197. Ulcerations of little finger in ulnar nerve paralysis.

In the cases observed soon after injury, of 11 in which the injury occurred in the arm, all muscles were weak only in 5 cases; the hypothenar were paralyzed in 4 cases, the interossei in 2 cases, and all muscles were paralyzed in one case. In 17 cases in which the injury was in the forearm, all muscles were weak in 6 cases, the hypothenar group was paralyzed in 4, the interossei in 3, all muscles were paralyzed in 3 cases and the adductor of the thumb and the flexor of the wrist in one each. It may be seen, then, that whether we are dealing with a lesion in the arm or in the forearm, the same order of frequency of paralyzed muscles exists. Those muscles paralyzed most frequently were, as noted by Bénisty, the hypothenar group and the interossei.

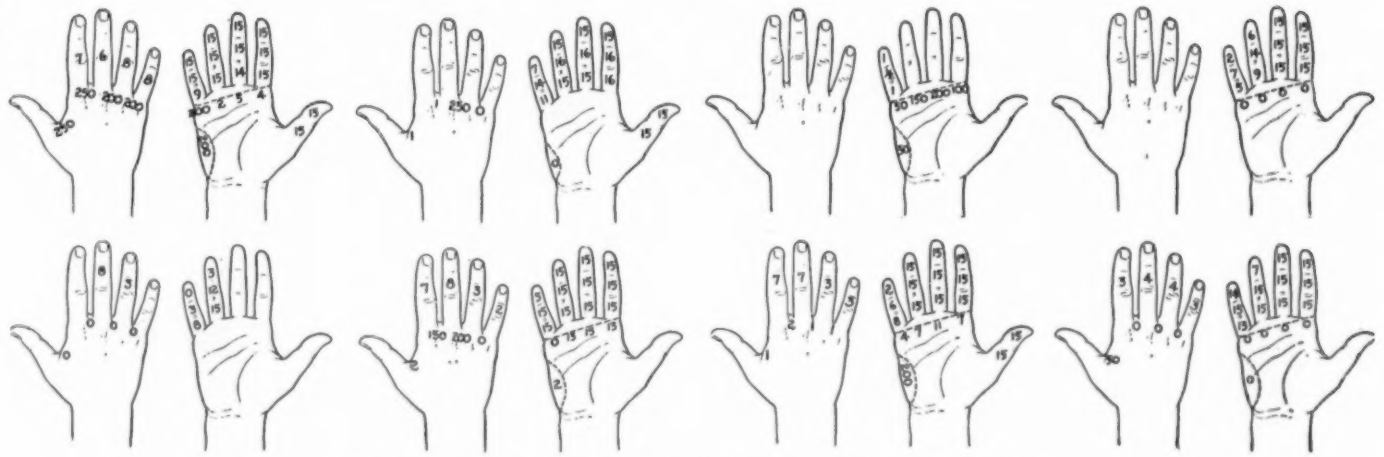
When there is a severe lesion of the ulnar nerve in the forearm or wrist below the level of the branching of the fibers and the flexor carpi ulnaris and flexor profundus digitorum, clawing is greatly exaggerated. Conversely, when the flexor carpi ulnaris and flexor profundus digitorum are only partly paretic but little clawing may be seen.

Partial Lesions

In recovering and partial lesions relatively greater strength in the phalanges is observed but may at times be an inaccurate guide to the severity of the lesion. Relatively greater strength in the abductor of the little finger, is an accurate guide as to the incompleteness of a lesion. Of course, any movement of the flexor carpi ulnaris or adductor of the thumb which is not supplementary in character determines an incomplete lesion. Of 16 partial or recovering lesions, 12 showed motor phenomena indicative of the severity of the lesion. In 9 severe cases not due to anatomic section, the motor phenomena were suggestive of partial lesion in 5 but conclusive in none. Physiologic interruption cannot be differentiated from anatomic section by the strength of movements of the phalanges of the fingers (Fig. 198).



A. Anatomical section verified at operation; complete loss of sensation.



B. Severe lesion, not anatomical section; complete loss of sensation.

FIG. 198. Dynamometric chart of small hand muscle movements in ulnar nerve paralysis.

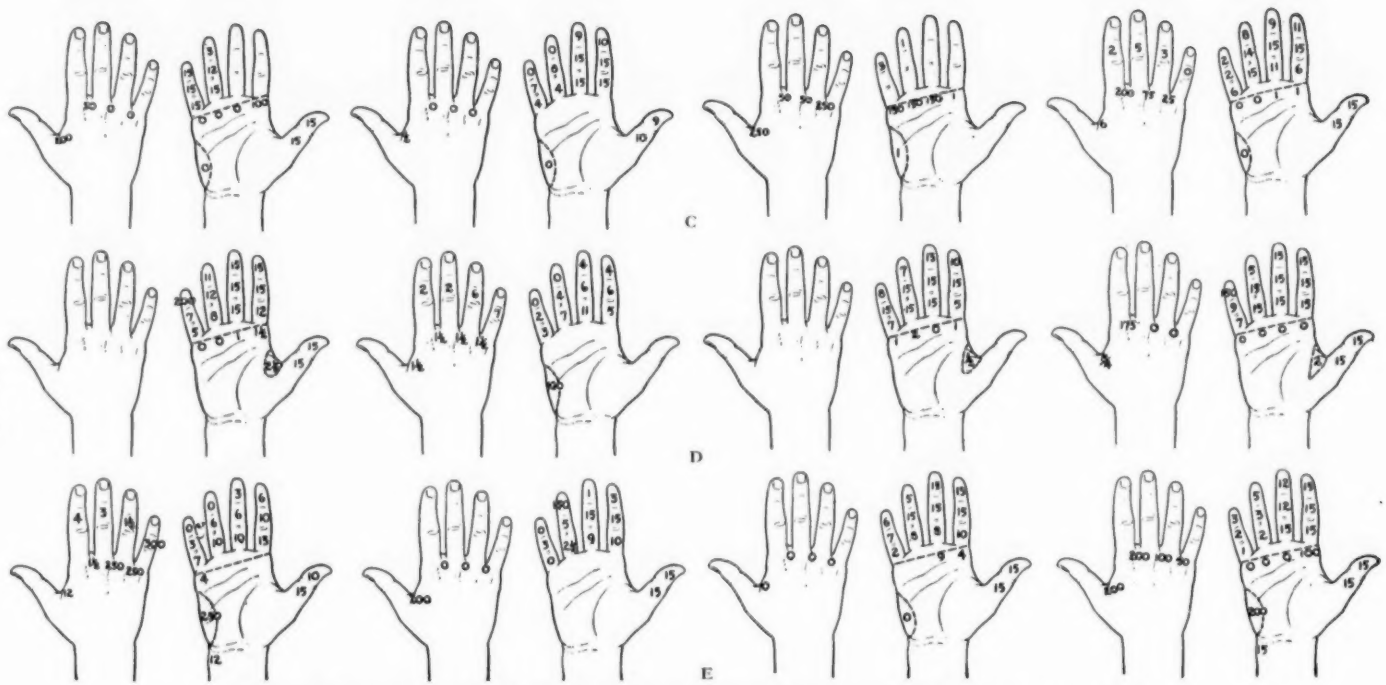


FIG. 198. Dynamometric chart of small hand muscle movements in ulnar nerve paralysis.

C. Compression of ulnar nerve, verified at operation; sensory loss partial.

D. Partial and recovering lesion not verified by operation; complete sensory loss.

E. Cases similar to D with some sensory regeneration. (Only four cases showed sensory regeneration in absence of motor recovery.)

Of 16 cases of recognized partial or recovering lesions, 11 showed incomplete sensory loss. Sensation was completely lost in all severe partial lesions. When sensory regeneration had occurred, usually motor recovery could likewise be demonstrated.

Signs of Motor Recovery

The order of recovery in ulnar nerve lesions is given by Bénisty as flexor carpi ulnaris, flexor profundus digitorum and, lastly, the small hand muscles which recover very slowly. The Committee upon Injuries of the Nervous System of the Medical Research Council stated that a better functional recovery is to be expected in the flexor carpi ulnaris, flexor profundus digitorum and in the abductor minimi digiti than in the other muscles.

It was pointed out before that because of supplementary motility the strength of movement of the phalanges was a misleading sign of recovery. Because of this, the cases seen some months after injury were analyzed from the standpoint of residual paralysis. Of 12 recovering cases of arm injury the hypothenar group was paralyzed in 8 cases, the interossei in 4 cases, the flexor carpi ulnaris in 2, the adductor of the thumb in 2 and all muscles in one case. In 14 cases of injury in the forearm, the interossei were paralyzed in 12 cases, the hypothenar in 9 cases, the adductor of the thumb in 4 cases and all muscles were weak in one case.

In another series it was noted that of 21 cases, in which movement had returned in the small hand muscles, the adductor of the thumb had recovered in 4 cases and the abductor of the little finger in 3 cases.

This is in general agreement with the authors just quoted, in that recovery occurs most regularly in the flexor carpi ulnaris and late in the small hand muscles; but that the adductor of the thumb recovered more frequently than the abductor of the little finger.

Complete recovery may be shown by the following sign which has been described by Pitres. With the palm placed flat upon the table and the fingers abducted, the patient can

FIG. 199. Pitres' test of recovery in ulnar nerve palsy.

move the little finger inward and outward and then scratch the top of the table with the nail of his little finger without moving his wrist (Fig. 199).

SIGNS OF SENSORY RECOVERY

Ulnar nerve lesions in general showed a larger number of cases in which there was but little sensory recovery when motor recovery had begun.

In those cases which recovered spontaneously, recovery of pain sense as well as diminution of degree of analgesia in the isolated sensory supply of the nerve was frequently noted. Return of pain and touch in patches occurred. Areas of return of pain and cold and persistent anesthesia to touch were noted. Almost complete return of sensation to cold, with anesthesia and analgesia was observed. In the cases which recovered following operation the loss to pain sense was generally greater but the same general characteristics were found. Particularly interesting were the areas of recovery of tactile sense in indentations and fissures (Figs. 200, 201).

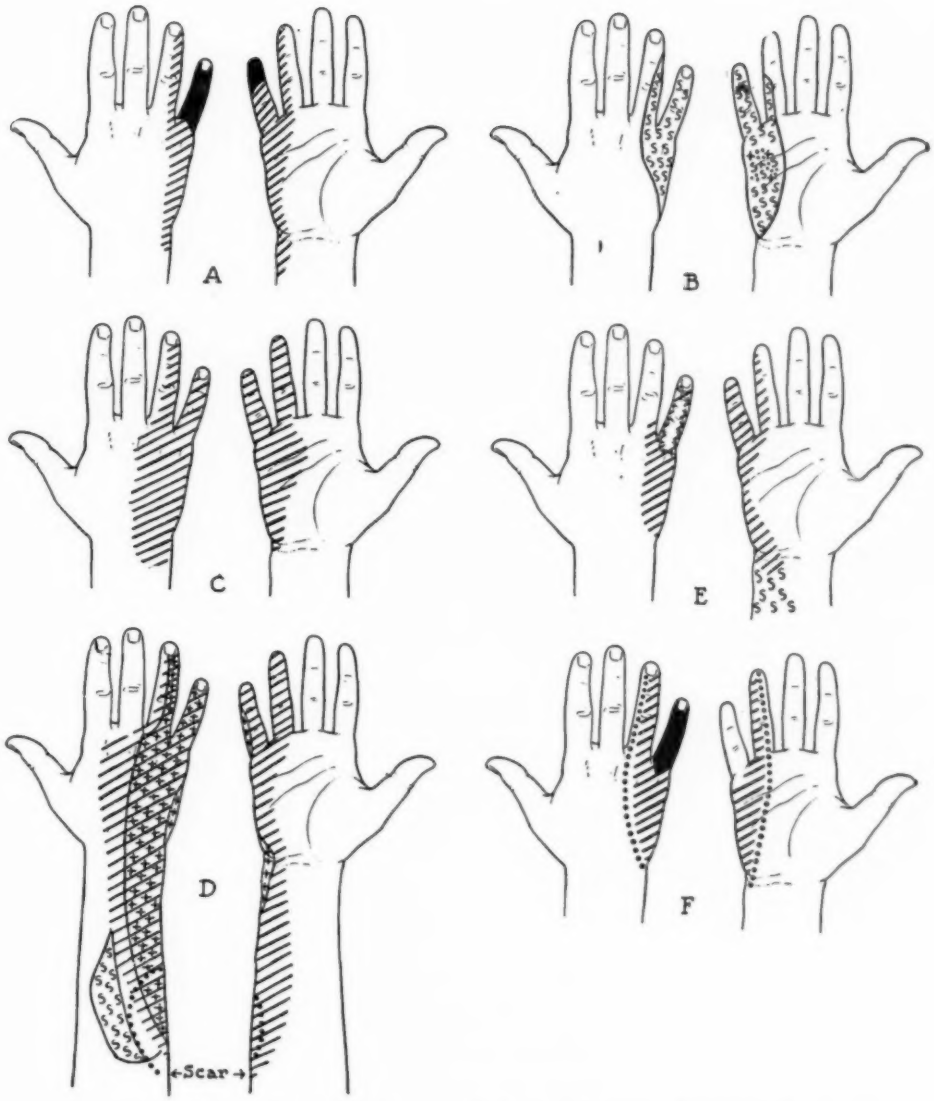


FIG. 200. Sensory loss of ulnar nerve lesions spontaneously recovering.

A. Rare severe lesion with marked sensory loss. B. Recovery of pain in isolated supply, diminished loss of touch. C. Recovery of pain. D. Recovery of pain in isolated supply, recovery of cold. E. Recovery of patch of pain and touch.

Differential Diagnosis

In civil life paralysis of the ulnar nerve must be distinguished from such lesions of the spinal cord as anterior

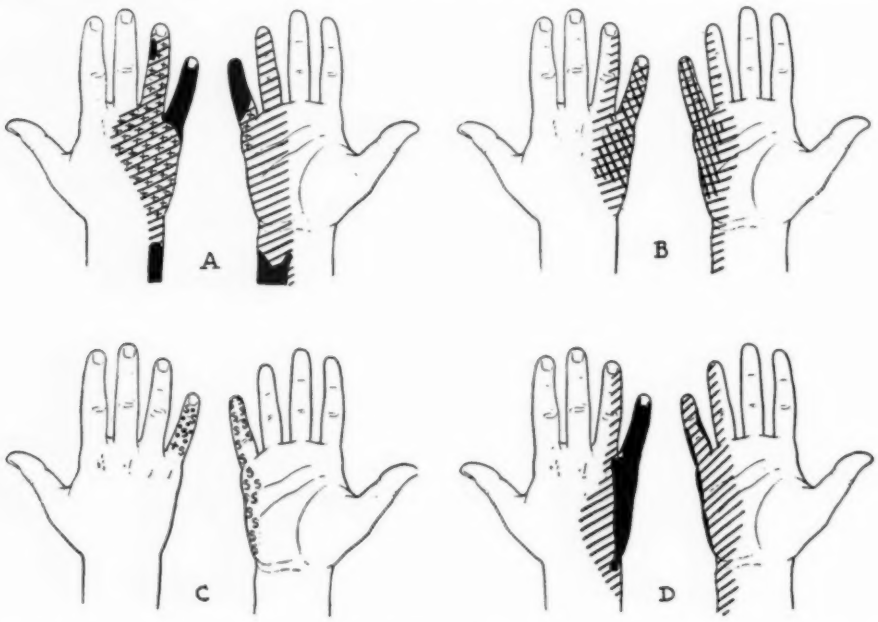


Fig. 201. Extensive loss of ulnar nerve lesions following operation. A. Extensive sensory loss, motor recovery. B. Diminished loss of pain. C. Patchy recovery of touch and complete recovery of pain. D. Recovery of pain in isolated supply of nerve.

poliomyelitis, syringomyelia, intramedullary tumors, meningomyelitis and progressive muscular atrophy. The lesions which affect only the anterior horns or the anterior horns and lateral columns are easily differentiated by the absence of sensory changes and the sparing of some muscles supplied by the ulnar nerve and paralysis of others not supplied by the ulnar nerve. Such disease as syringomyelia or intramedullary tumors present dissociated sensory changes and evidence of involvement of the pyramidal tracts in the lower extremity. The latter is likewise true of meningomyelitis and extramedullary tumors.

Ischemic paralysis and Volkmann's contracture may be differentiated, as was indicated in the chapter on the Median Nerve, by the absence of sensory changes limited to the distribution of the ulnar nerve, the induration of the muscles,

vascular disturbances, and by the absence of the reaction of degeneration.

Anatomy

The ulnar nerve arises from the inner cord of the brachial plexus and is therefore made up of fibers derived from the anterior divisions of the eighth cervical and first thoracic spinal nerves. Occasionally fibers from the seventh cervical nerve may join the ulnar. Kerr has stated that infrequently it may arise from a single root and Sterzi concludes that it is a branch from the median nerve.

In the axilla the nerve is placed rather deeply between the axillary artery and vein and lies medial to the median nerve. When the arm is abducted the nerve passes beneath the axillary vein. It follows along the internal border of the artery which separates it from the median nerve. The musculocutaneous nerve lies more anteriorly and laterally; the medial cutaneous nerves to the arm and forearm are medial to the ulnar and lie upon it and the axillary vein. The radial nerve lies behind the artery and is therefore external and posterior to the ulnar. The ulnar nerve leaves the axilla, from beneath the pectoralis major muscle, lying upon the surface of the teres major and latissimus dorsi muscles.

In the upper third of the arm the internal intermuscular septum, upon which it lies, separates the ulnar from the triceps muscle. As the nerve descends the brachial artery still lies anterior and external. The median nerve is more anteriorly placed at the external side of the artery. The radial still lies posterior and external but is in closer relation to the ulnar. The nerve follows the internal bicipital groove formed by the biceps muscle in front and the brachialis anticus muscle behind. In slender individuals it can be palpated through the skin, thin aponeurosis and subcutaneous tissue. At a level between the middle and inferior thirds of the arm the ulnar pierces the median intermuscular septum and the inner head of the triceps to reach a plane posterior to the medial condyle

of the humerus. Just above the medial condyle the nerve enters a groove behind the humerus. It is accompanied by the inferior profunda artery and is covered posteriorly by an aponeurosis which extends between the olecranon and the medial condyle. In this aponeurosis are transverse and longitudinal fibers which are the remains of the rudimentary epitrochleo-anconeus muscle, and which receive a small branch from the ulnar. Gegenbaur has described a bursa which separates the nerve from the internal lateral ligament and which allows free movement of the nerve during flexion and extension of the forearm.

The nerve reaches the forearm by passing between the two heads of origin of the flexor carpi ulnaris muscle. As the ulnar lies in the groove of the medial condyle it is joined by the posterior ulnar recurrent artery and vein which lie externally. The artery anastomoses with the inferior profunda which has accompanied the ulnar nerve from above. In the forearm the nerve lies upon the flexor digitorum profundus muscle and is covered by the flexor carpi ulnaris. It becomes more and more superficial lying in the cleft between the flexor digitorum sublimis and the flexor carpi ulnaris. In the upper third of the forearm the ulnar artery and its accompanying veins join the nerve lying externally to it (Fig. 202). The ulnar reaches the level of the anterior annular ligament, passes through a special canal in this structure upon the radial side of the pisiform bone and reaches the palm of the hand where it breaks up into its terminal branches (Fig. 203). The ulnar nerve gives off no branches in the arm. About 4 cm. above the medial condyle of the humerus an *articular* branch arises. This branch and its ramifications pass horizontally and externally to become lost within the capsule of the elbow joint.

At a slightly lower level below the bend of the elbow *muscular* branches are supplied to the flexor carpi ulnaris and the inner half of the flexor digitorum profundus muscles. The flexor carpi ulnaris receives a branch as the nerve passes between its two heads of origin. It also receives innervation

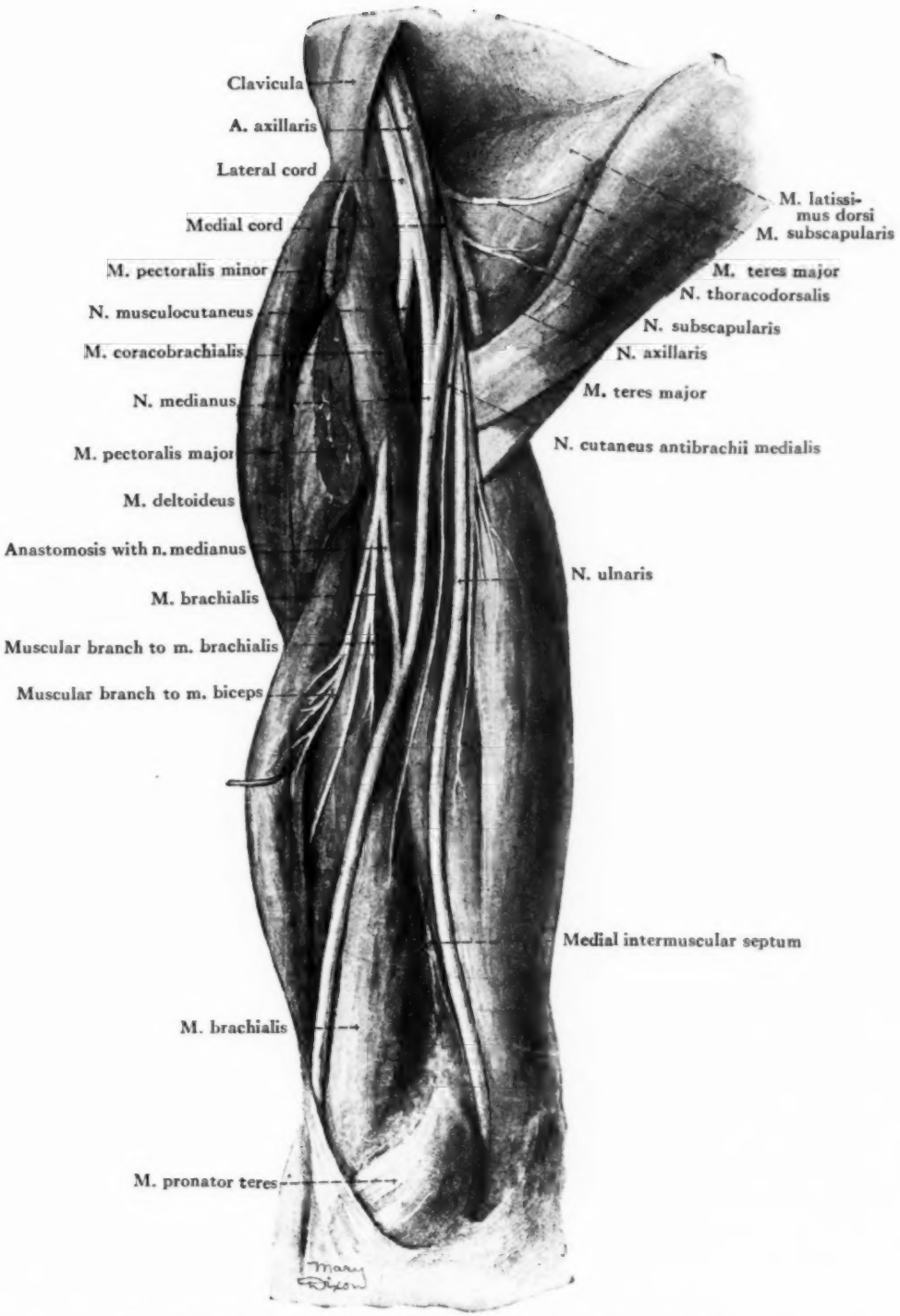


FIG. 202. Anatomical course of ulnar nerve in axilla and upper arm.

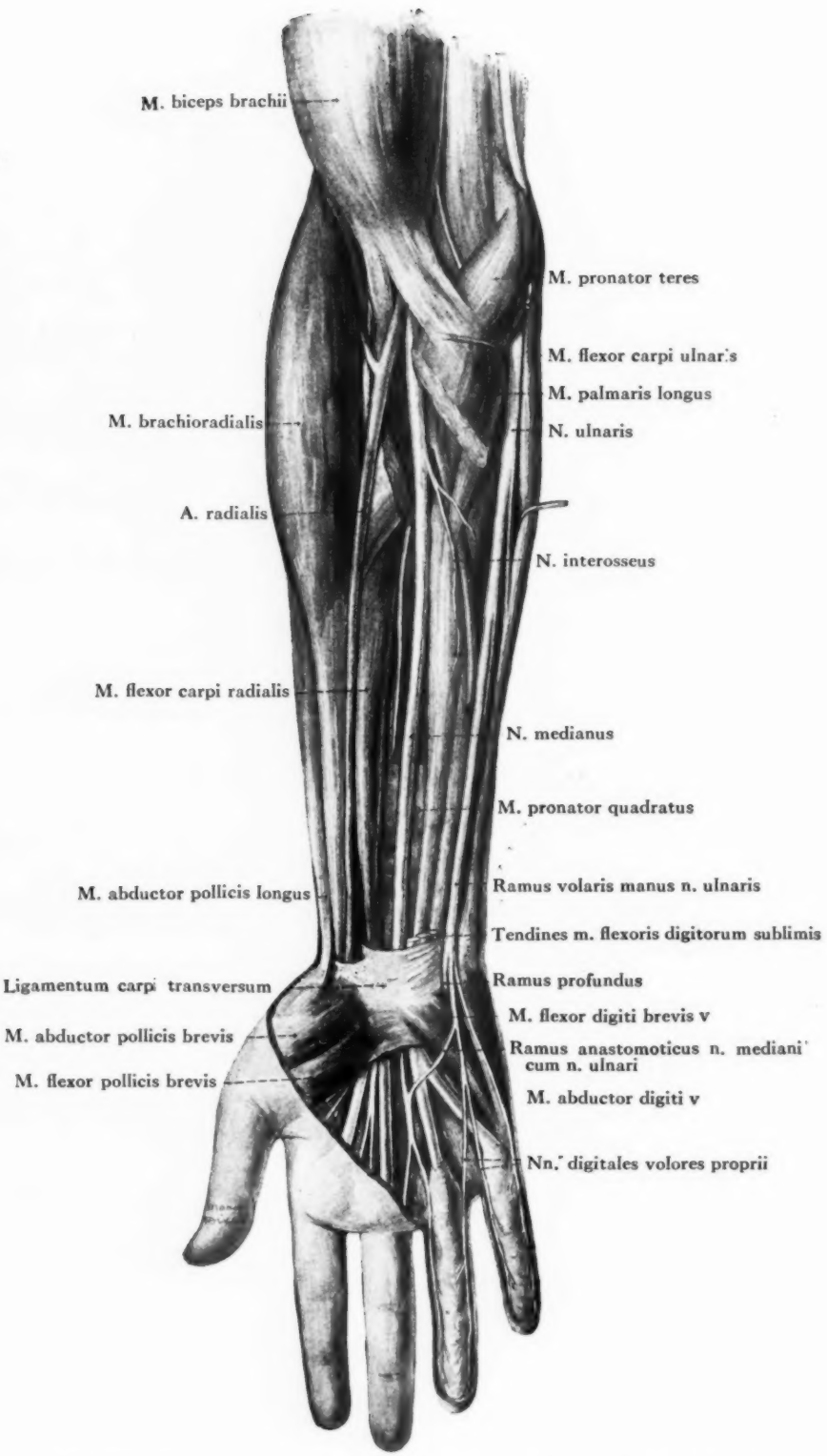


FIG. 203. Anatomical course of ulnar nerve in forearm, wrist and hand.

in its middle third and from the ulnar or from the branch to the flexor digitorum profundus. The latter muscle receives two branches from the ulnar in the upper third of the course of the nerve in the forearm. They are larger than the branches to the flexor carpi ulnaris.

A large *dorsal cutaneous branch*, which may be mistaken for the parent ulnar trunk, arises at the junction of the middle and lower third of the nerve in its course in the forearm. It descends beneath the tendon of the flexor carpi ulnaris muscle and passes posteriorly to reach the dorsal surface on the inner aspect of the hand. This branch supplies sensation to the dorsal surface of the little finger and part of the dorsal aspect of the ring and middle fingers. This branch may arise from the ulnar trunk just below the medial condyle or as low as the styloid process (Henle, Krause). A slender *branch to the ulnar artery* arises in the middle third of the trunk of the nerve. It accompanies the vessel into the palm where it anastomoses with a digital branch of the median.

After the ulnar passes through the canal in the anterior annular ligament it breaks up into its two *terminal branches*. The *superficial* branch which crosses the flexor digiti quinti brevis muscle after a short course divides into three terminal branches. One of these ramifications innervates the small palmaris brevis muscle which lies in the skin of the hypothenar eminence. The two other branches are sensory in function. One passes distally across the palmar surface of the hand to become the digital nerve on the ulnar aspect of the little finger. The other gives off a twig to join the digital branches of the median and then continues distally to end as the digital nerve to the ulnar aspect of the ring finger and the radial surface of the little finger.

The *deep branch* is entirely muscular in its supply. It passes toward the radial side of the palm between the abductor and flexor digiti quinti muscles. It lies deeply in close relation to the deep palmar arterial arch. It supplies all of the muscles of the hypothenar eminence, the two inner lumbricales,

and all of the palmar and dorsal interosseous muscles. It ends by supplying the adductor pollicis muscle and the inner head of the flexor brevis pollicis, where its twigs may anastomose with those of the median which supply the outer head of the flexor brevis pollicis.

Physiology

Most of the muscles of the hand are supplied by the ulnar nerve. The *flexor carpi ulnaris* muscle flexes the wrist and draws it ulnarward. It does not adduct the wrist. The *two inner heads* of the *flexor digitorum profundus* flex the second and the terminal phalanges of the ring and little fingers. There are seven *interosseous* muscles; four *dorsal* and three *palmar*, all of which are innervated by the ulnar nerve. The interossei produce flexion at the metacarpophalangeal joints and extension of the second and terminal phalanges. They also abduct and adduct the fingers. The *lumbricales* also flex the metacarpophalangeal joints. There are four muscles in the hypothenar eminence: the *palmaris brevis*, *abductor minimi digiti*, *flexor brevis minimi digiti*, *opponens minimi digiti*. The abductor minimi digiti draws the little finger toward the ulnar side of the hand. It also aids the flexor brevis minimi digiti to produce flexion at the metacarpophalangeal joint of the little finger. The opponens minimi digiti draws the fifth metacarpal bone forward and outward.

The *adductor pollicis* and the inner head of the *flexor brevis pollicis* have an analagous action. They flex slightly the first phalanx of the thumb, tilt its inner border and rotate it on its long axis. The result is that the metacarpal of the thumb is drawn outward and in front of the second metacarpal. These muscles also extend the second phalanx of the thumb upon the first. When they are fully contracted the first metacarpal bone is on a level with the second, the second phalanx is extended and the first phalanx is closely applied to the outer border of the metacarpophalangeal joint of the first finger.

Book Page 364

Surgery

An isolated injury to the ulnar nerve in the axilla is rarely found. A combined lesion of the terminal portion of the brachial plexus or of the ulnar with the median or radial is of more common occurrence. As the ulnar leaves the axilla it passes across the tendon of the latissimus dorsi muscle in close relation to the radial and both nerves commonly suffer simultaneous injury.

The nerve is exposed by dissecting free the axillary vein and retracting it either inward or outward, whichever may be the most convenient. If there is a great amount of scar tissue present, the pectoralis major muscle should be divided and retracted inward so that the fatty substance in the axilla may be freed from the axillary vein and displaced toward the chest wall. The intercostobrachial and medial cutaneous nerve to the arm may be divided. If the ulnar is bound by scar tissue to the posterior wall of the axilla, it may be necessary to divide the subscapular artery in a manner similar to that used in dissecting the axilla free from malignant disease. In so doing the nerve to the latissimus dorsi muscle (subscapular) should be preserved. If the ulnar is involved close to its origin from the brachial plexus, a concomitant injury of the median is not uncommonly found. Both nerves may require suture to the inner cord of the brachial plexus.

To prepare the patient with an ulnar nerve lesion in the arm the arm is abducted to a right angle to the body and the elbow and forearm are supported by a sandbag.

A long incision is made parallel to the neurovascular bundle in the groove between the biceps and triceps muscles where these structures can be palpated in slender individuals (Fig. 204). At the junction of the middle and lower thirds of the arm the incision should be directed posteriorly, following the intermuscular septum, to the medial condyle of the humerus.

The neurovascular bundle should be opened after it is exposed by dividing the deep fascia. The ulnar should be

identified above the lesion and localization sutures should be placed in the perineurium before the nerve is completely isolated so that it is not rotated during its further exposure.

FIG. 204. Line of incision to expose ulnar nerve in arm.

Considerable difficulty may be experienced with bleeding if the neurovascular bundle is involved in dense scar tissue.

In the lower third of the arm the nerve is to be found superficially within the fibers of the triceps. Bleeding from the inferior profunda artery may interfere with the exposure unless the vessel is isolated and kept under control both from above and below. It will be remembered that the anterior and posterior ulnar recurrent arteries form a collateral circulation with the inferior profunda in this region.

As the ulnar passes behind the medial condyle of the humerus to lie in the olecranon groove it is exposed to frequent trauma. In war injuries its involvement was second only to that of the radial. It may be involved very commonly in a fracture about the elbow joint. Often the original trauma to the medial condyle or elbow joint may be slight and years later ulnar paralysis may develop. Cases have been reported in which the first signs of nerve involvement appeared thirty years or more after injury (Stookey, Hunt, Adson). In some individuals the groove for the ulnar nerve is shallow so that the nerve may subluxate frequently and thus give rise to irritative symptoms.

The position of the extremity for operation should be with the arm fully abducted and externally rotated. The incision should extend upward along the course of the nerve in the

lower third of the arm and downward into the upper forearm. It should be slightly curved with its center crossing the medial border of the olecranon (Fig. 205).

FIG. 205. Line of incision to expose ulnar nerve at elbow.

After dividing the deep fascia, the vessels already mentioned should be ligated to avoid troublesome bleeding. The ulnar collateral branch of the radial nerve, which supplies the medial head of the triceps, lies in close relation to the ulnar along the posterior border of the internal intermuscular septum and should be avoided. Leaving the olecranon groove, the ulnar will be found passing beneath the connection arch between the two heads of the flexor carpi ulnaris which may be divided to expose the nerve thoroughly. At this level it is extremely important to preserve the branches which innervate the flexor carpi ulnaris and the ulnar half of the flexor digitorum profundus muscle.

Because of irritation from repeated traumas or because of a large defect in the continuity of the ulnar which results from resection of the neuromas it may be necessary to transpose the ulnar nerve from the olecranon groove to the anterior surface of the elbow. In this way a defect of from 3 to 4 inches may be overcome, not only by shortening the course of the nerve trunk but by avoiding tension upon it by flexion of the elbow.

The incision is similar to that just described but, in addition, the anterior skin flap is reflected to expose the medial edge of the biceps muscle and its tendon. The posterior flap is undermined sufficiently to allow exposure of the fascia attached to the olecranon. The nerve is freed from its bed and if necessary the articular branches may be severed to get free mobilization. The branches to the flexor carpi ulnaris and flexor digitorum profundus may interfere with mobilization and if so they should be dissected carefully off the sheath of the parent trunk to their origin. This will obtain mobilization and still preserve these branches. The nerve is then carried anteriorly to lie on the bellies of the muscles which arise from the medial condyle. Care must be taken to prevent angulation or constriction. It may be held in place by separating the posterior deep fascia from the medial condyle, bringing it forward and suturing it over the ulnar to the anterior deep fascia. This should be done loosely enough not to constrict the nerve and yet far enough to prevent the nerve from slipping back into its original position.

If the transposition is to be done for defect in the nerve, either the central or distal end of the nerve may be transposed, depending upon the location of the injury. If the branches to the flexor carpi ulnaris and flexor digitorum profundus have been destroyed or are to be sacrificed the end to be transposed is drawn through a tunnel made by passing a closed blunt hemostat beneath the flexor digitorum sublimis and pronator teres upon the flexor digitorum profundus. This must be passed between those muscles and not through them. This transposition should be done before the neuromas are resected and care should be taken so to identify the surfaces of the cut ends of the nerve that axial rotation will not occur. If the branches to the flexor carpi ulnaris and flexor digitorum profundus muscles are sacrificed deliberately for purposes of mobilization, they should be divided close to the muscles so that after transposition of the trunk, they may be implanted into the muscles directly to secure neurotization. If this is

impossible, the tendons of the flexor digitorum profundus to the fourth and fifth fingers may be implanted into those of the second and third fingers and the palmaris longus tendon

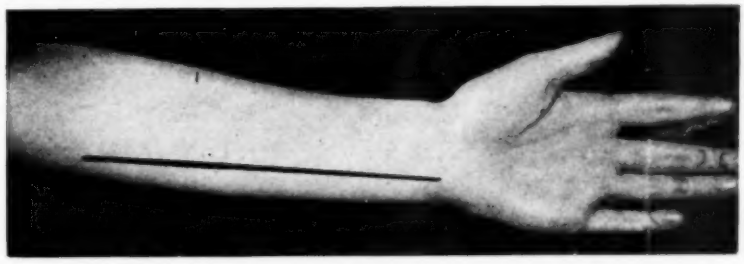


FIG. 206. Line of incision to expose ulnar nerve in forearm.

may be sutured to the distal end of the flexor carpi ulnaris tendon. This procedure usually gives good functional results. The nerve may be transposed to lie on the surface of the flexor muscles, but if this is done 1 to 2 cm. is lost in bridging the defect.

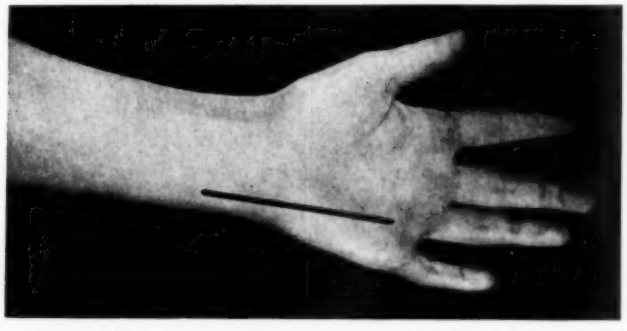


FIG. 207. Line of incision to expose ulnar nerve at wrist.

An incision from the radial side of the pisiform bone toward the medial condyle will follow the course of the ulnar nerve in the forearm (Fig. 206). It is advisable to identify the nerve near the wrist. It may be followed upward by separating the loose attachment between the flexor carpi ulnaris and the flexor digitorum sublimis. The large dorsal cutaneous branch which passes beneath the tendon of the flexor carpi ulnaris should not be confused with the parent trunk.

Lesions of the ulnar nerve in the lower third of the forearm and at the wrist are commonly associated with severance of the flexor tendons. The latter should be freed of all scar tissue and reunited. Loss in continuity because of a defect may be compensated for by flexion of the hand at the wrist and many times an end-to-end suture may be obtained in this manner. (Fig. 207.)

To expose the ulnar nerve at the wrist an incision is made along the radial border of the flexor carpi ulnaris tendon radial to the pisiform bone and into the palm in the direction of the third interspace. The anterior annular ligament is opened to expose the nerve in its special compartment. The opponens and abductor digiti quinti muscles may be separated from their origin on the uncinate bone. If they are reflected ulnarward the nerve will be exposed. In an attempt to repair the small motor or cutaneous branches of the ulnar in the hand, extreme care should be used and the difficulties of the situation should be realized. The impairment of function which might result from the necessary surgical trauma may far overshadow the original disability.

Chapter XXV

COMBINED MEDIAN AND ULNAR NERVE LESIONS

Concomitant injury to the ulnar and median nerves is a common occurrence. When the lesions are complete the appearance of the hand and the disturbance of function is constantly the same. If both nerves have suffered incomplete lesions, or if one is completely paralyzed and the other only partially injured, the clinical manifestations may differ widely. So many varieties of such injuries may occur as to lead to classifications which are based upon the varied appearances and functions of the hand.

Motor Symptoms

In the case of total paralysis of both nerves the appearance of the hand is quite characteristic. The wrist is slightly hyperextended and the hand inclined to the radial side. The thumb is slightly abducted and lies in the plane of the palm, producing the appearance of an "ape hand." The first phalanges are moderately extended and slight passive flexion of the last two phalanges occurs. Marked wasting is seen in the thenar and hypothenar eminences and in the dorsal interossei. The flexor tendons of the fingers appear prominently in the palm. No flexor movements are possible except as they occur as the result of supplementary movements. No movement occurs in the little finger, and except for extension and abduction of the thumb in the plane of the palm no movement is possible in the thumb (Fig. 208).

Supplementary Movements: Slight passive movement of flexion at the wrist is produced by hyperextension of the hand with sudden relaxation. Active contraction of the abductor longus pollicis assists in carrying out this movement of flexion. At times this muscle is capable of producing flexion in the absence of relaxation following hyperextension (Fig. 209). Flexion of the fingers is similarly performed by hyperextension

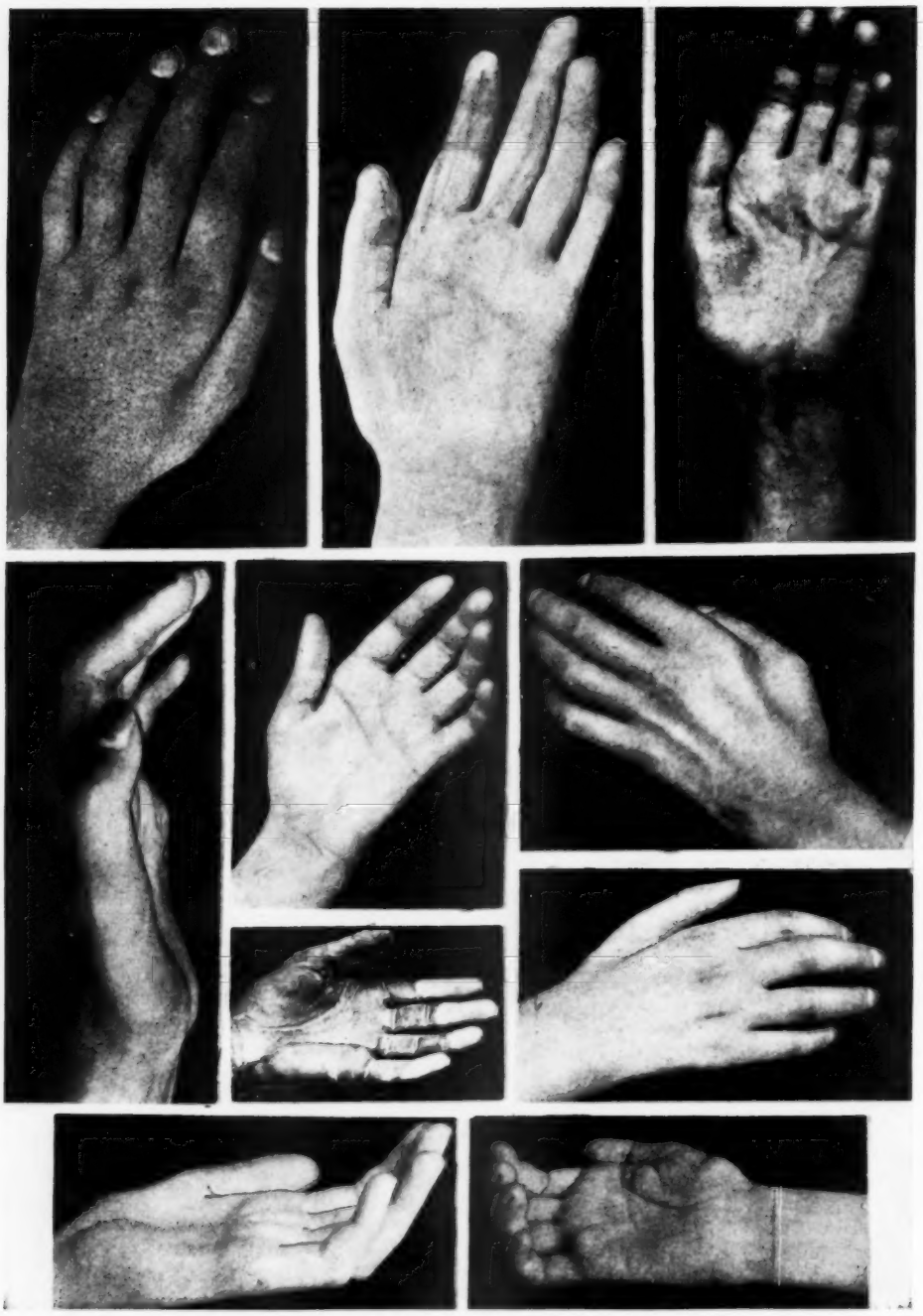


FIG. 208. Characteristic appearance of hand in combined median-ulnar nerve paralysis.

of the hand and extension of the fingers which are then suddenly relaxed. Slight abduction of the fingers may be produced by energetic contraction of the extensors.

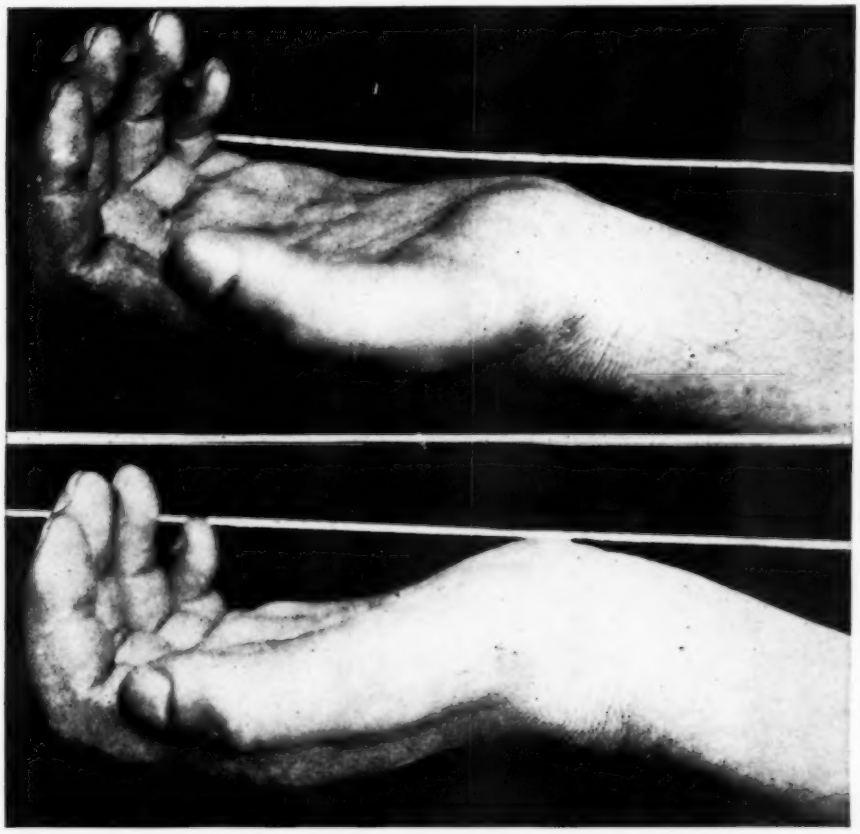


FIG. 209. Flexion of wrist by supplementary movement of extensor ossei metacarpi pollicis in median-ulnar nerve palsy.

SENSORY SYMPTOMS

The loss of sensation in combined median and ulnar nerve lesions is marked. Tactile sensibility is lost over the area which represents the sensory distribution of both nerves; that is, over the palmar and the dorsal surfaces of all the fingers, excepting the area supplied by the radial nerve and the ulnar border of the dorsum of the hand. Sensation to pain and high and low degrees of temperature is preserved over a variable

area corresponding to the overlap of the radial and musculocutaneous nerves. Usually the thumb, the radial half of the palm, the proximal phalanges of the index, middle, and part or

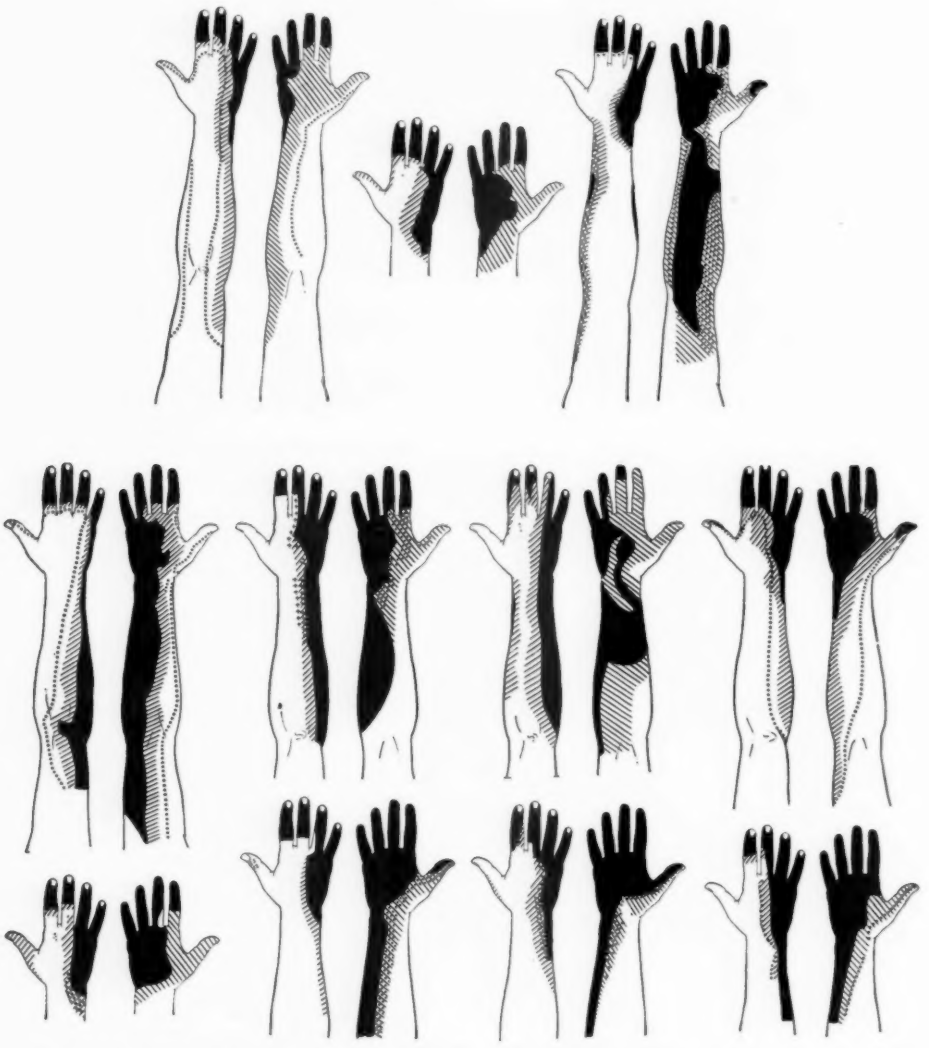


FIG. 210. Sensory loss in combined median-ulnar nerve lesions. (In some instances medial cutaneous nerve of forearm and in others medial cutaneous nerve of forearm and musculocutaneous nerve were injured simultaneously.)

all of the proximal phalanx of the ring finger, are sensitive to pin prick. There is no sensation to deep pinching over the

distal phalanges of any of the fingers. The appearance of a sensory chart showing the dissociation of sensation is characteristic and is easily distinguished from that of a partial or

FIG. 211. Trophic nail changes in combined median-ulnar nerve palsy.

recovering lesion (Fig. 210).

VASOMOTOR, SECRETORY AND TROPHIC CHANGES

These are much the same as those seen in cases of paralysis of the ulnar and median nerves alone. Changes in the nails are prominent, as are coldness, dryness and discoloration of the skin. When associated with a vascular lesion, which is common, pronounced vasomotor changes, with cyanosis, glossy skin or edema and marked deformity of the nails occur (Fig. 211).

PARTIAL LESIONS

Partial lesions of the ulnar and median nerves produce many interesting types of dissociated paralysis. A number of these have been described by Bénisty. In one type the small hand muscles and flexors of the fingers alone are paralyzed. In another there is in addition to the paralysis of the small hand muscles only a paresis of the deep flexors which produces a very marked clawing of the proximal phalanges. A number of other types have been described but their recognition is

important only in calling attention to the incomplete paralysis. Careful dynamometric studies show that when observed some time after injury anatomic section of both ulnar and median

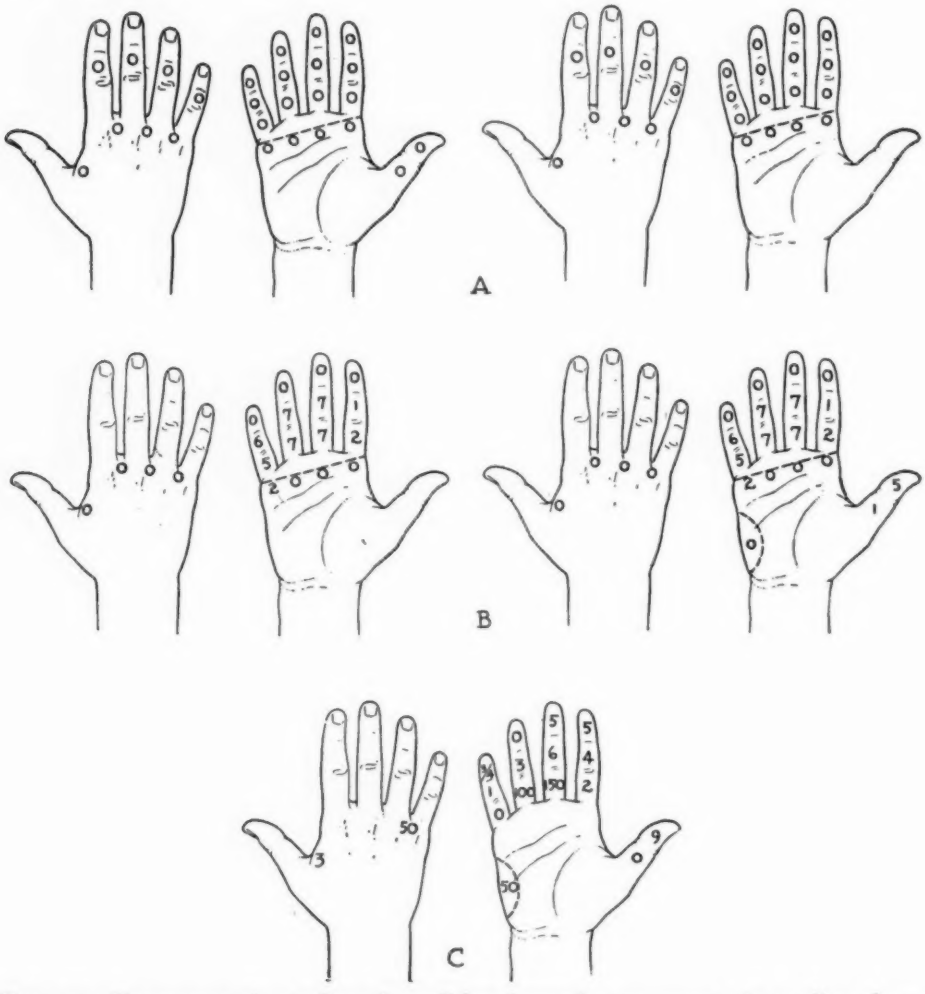


FIG. 212. Dynamometric studies of small hand muscles movements in median-ulnar nerve lesions.

A. Anatomical section; complete sensory loss.

B. Incomplete but severe lesion; complete sensory loss over unar, incomplete sensory loss over median area.

C. Incomplete but severe lesion; incomplete sensory loss over ulnar and median.

nerves produced complete paralysis of all of the phalanges of the fingers and thumb and severe lesions, not anatomic sec-

tions, showed some movement in some of the phalanges of all of the fingers. In incomplete lesions of either ulnar or median nerves weak movements of the phalanges of the fingers, inter-

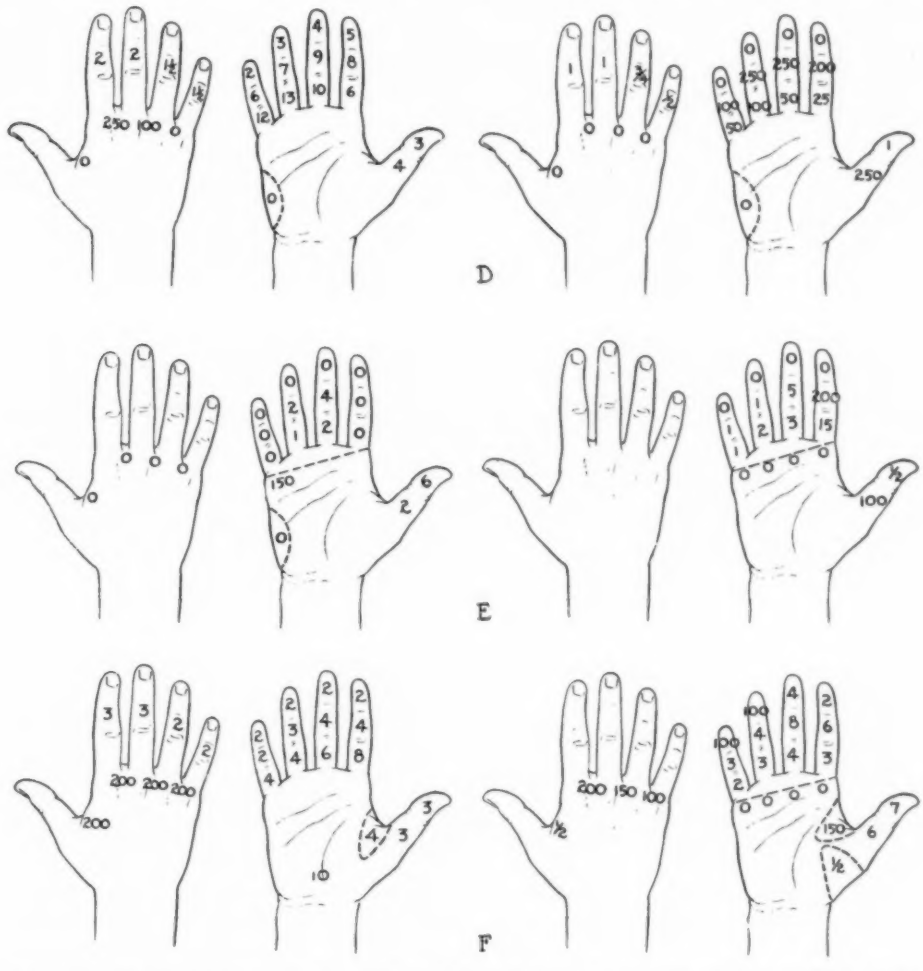


FIG. 212. Dynamometric studies of small hand muscles movements in median-ulnar nerve lesions.

D. Incomplete but severe lesion; complete sensory loss over ulnar and median.

E. Complete ulnar, incomplete median; sensory loss over ulnar complete, over median, incomplete.

F. Incomplete or recovering lesion; sensory loss over ulnar complete; no loss over median in three and only partial loss in two cases.

preted alone, are insufficient guides to whether or not one of these nerves is severed, and if severed, which one. Because of

the widespread supplementary motility, recovery of function is difficult to study and a definite pattern of involvement cannot be determined (Fig. 212).

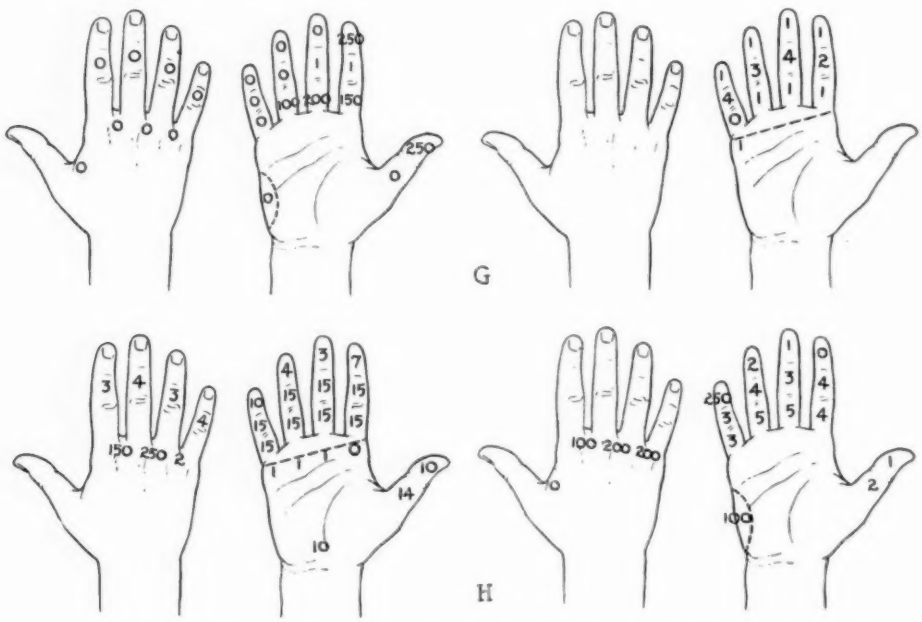


FIG. 212. Dynamometric studies of small hand muscles movements in median-ulnar nerve lesions.

G. Complete ulnar analgesia and incomplete sensory loss over median with regeneration of ulnar nerve.

H. Incomplete ulnar and median nerve lesions; no sensory loss in ulnar; slight sensory loss in median nerve area.

When observed some time after injury (more than five months) it would appear that anatomic section of both ulnar and median nerves produces complete paralysis of movement of all of the phalanges of the fingers and thumb. Severe lesions, not anatomic sections, showed some movement in some of the phalanges of all of the fingers.

As in isolated lesions of the median nerve, so when combined with an ulnar nerve lesion, it was seen that in partial or recovering lesions and in more than half of the severe lesions, not anatomic sections, incomplete sensory loss in the median distribution was present.

Only a few of the cases of incomplete ulnar and median nerve lesions showed incomplete sensory loss in the ulnar distribution, and in only one of seventeen cases was this the

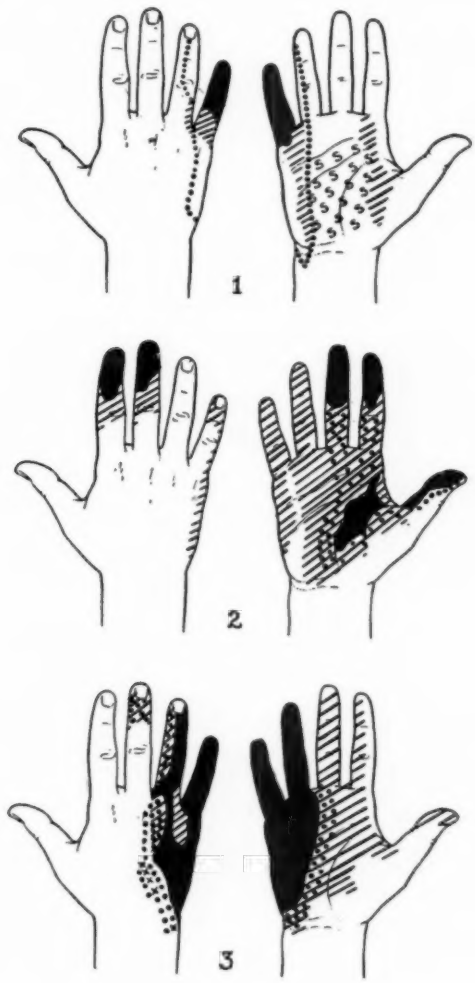


FIG. 213A.

A. Ulnar and median nerve lesions; postoperative recovery. 1. Return of sensation in area between injured nerves. 2. Neurolysis of ulnar, section of median with suture; return of pain but not cold sensation. 3. Neurolysis of median, section and suture of ulnar; patchy return of pain sense in ulnar distribution.

case when phenomena of motor regeneration were inconclusive. Only one severe incomplete lesion showed incomplete sensory

loss of the ulnar. In complete lesions of the ulnar and incomplete lesions of the median when sensory regeneration was demonstrable motor regeneration was likewise present.

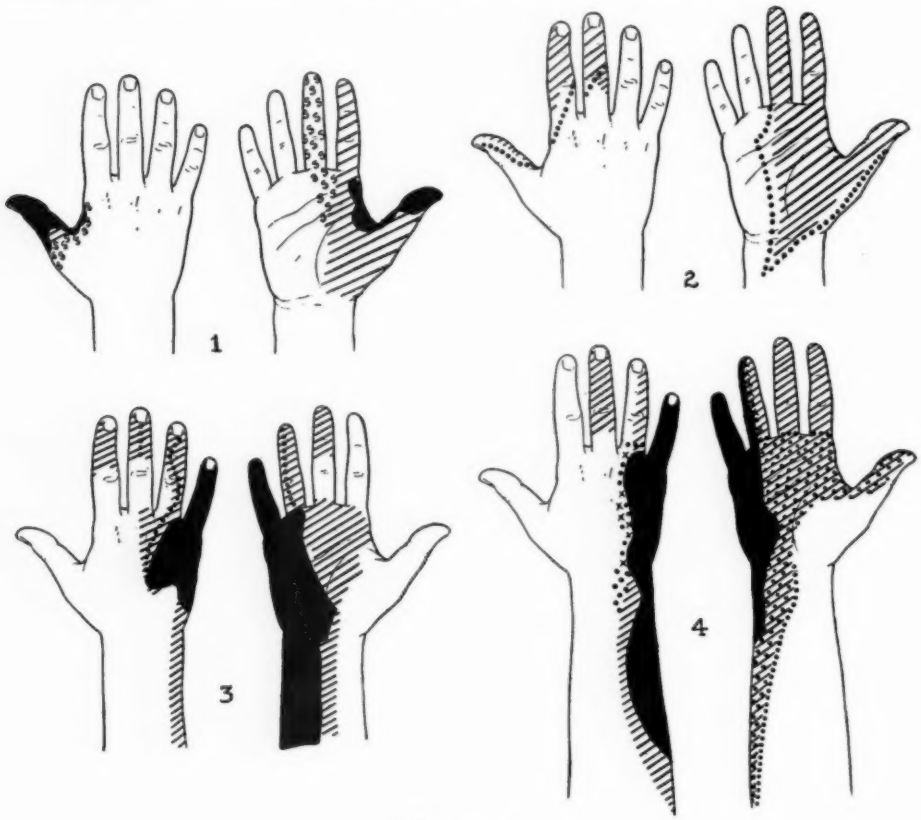


FIG. 213B.

B. Ulnar and median nerve lesions; spontaneously recovering. 1. Complete recovery of ulnar; recovery of pain in isolated area of median and diminished tactile loss. 2. Recovery of ulnar. Marked loss of cold but no loss of pain sense in area and median nerve. 3. Marked sensory loss in ulnar area; recovery of pain, touch and temperature sense in isolated supply of median. 4. Recovery of cold and temperature sense in isolated supply of median.

SIGNS OF MOTOR RECOVERY

The motor recovery follows the course of recovering isolated lesions of the median and ulnar nerves.

SIGNS OF SENSORY RECOVERY

Sensory recovery followed the same course, and a notable observation is the return of sensibility in the area between the

sensory supply of the ulnar and median nerves. This is never noted in complete lesions.

Interlacing, patchy return, return of sensibility in areas of isolated supply and dissociation and loss to cold and touch were also observed (Fig. 213).

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